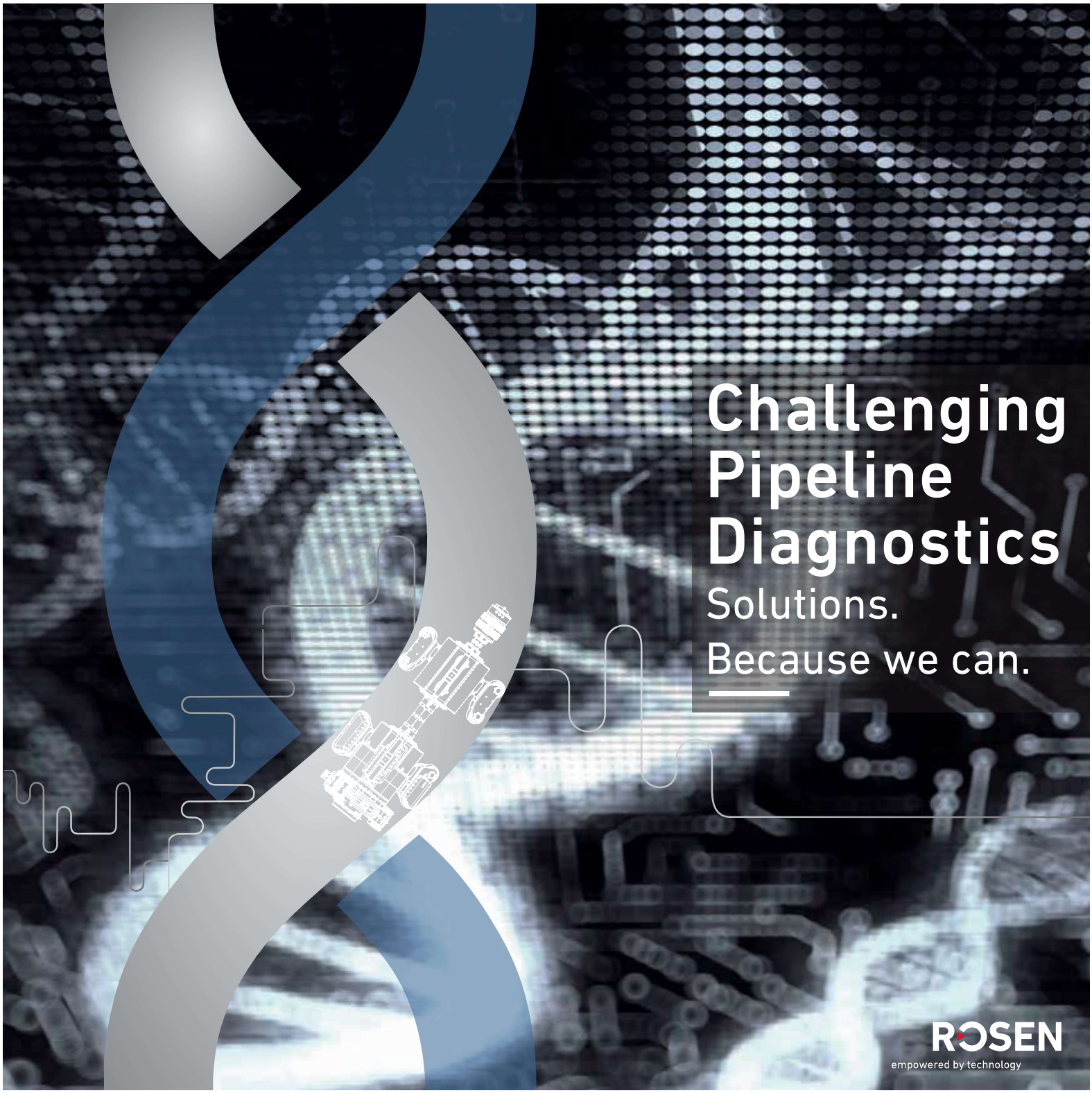
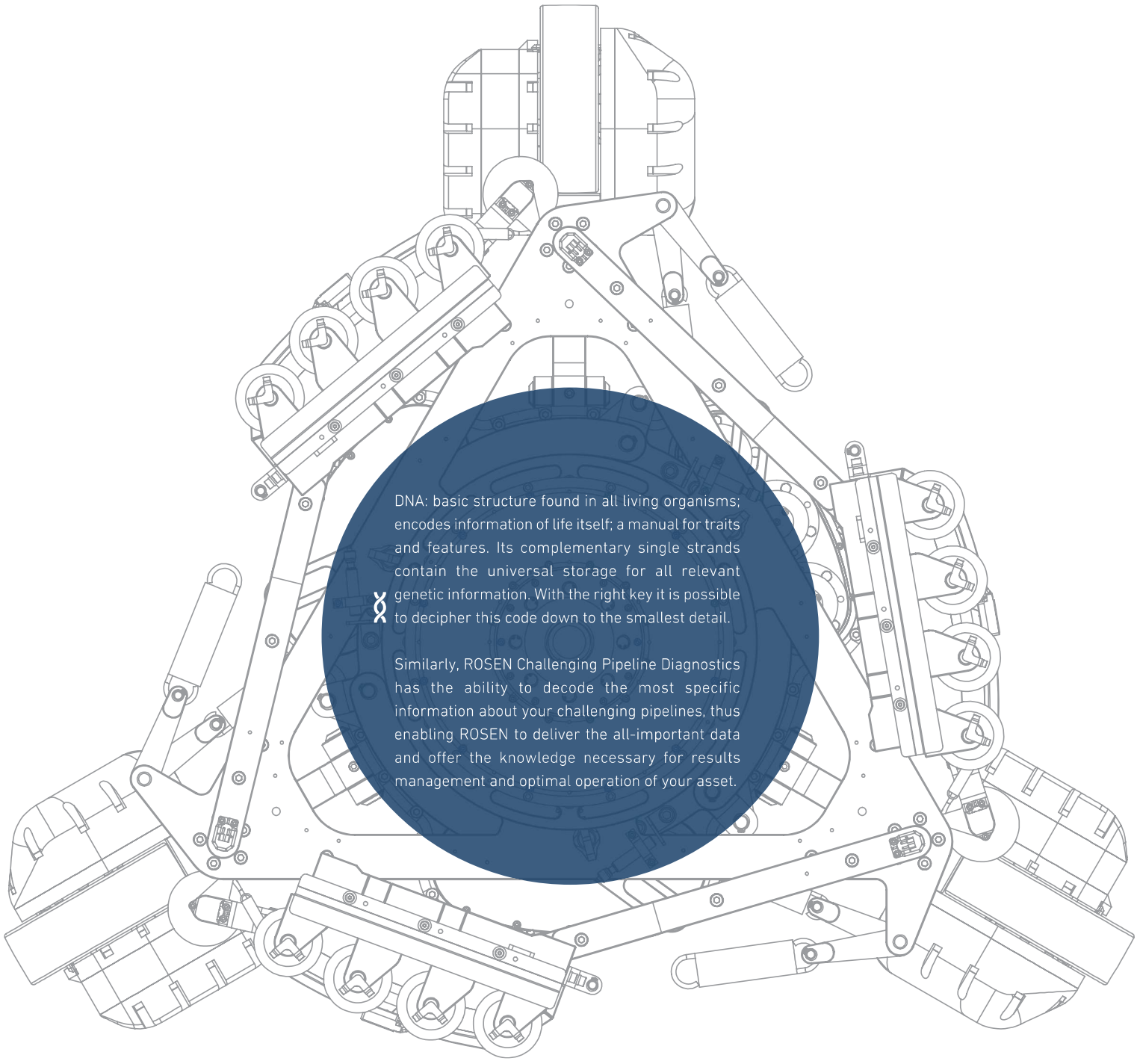

Challenging
Pipeline
Diagnostics
Solutions.
Because we can.
ROSEN
empowered by technology



DNA: basic structure found in all living organisms; encodes information of life itself; a manual for traits and features. Its complementary single strands contain the universal storage for all relevant genetic information. With the right key it is possible to decipher this code down to the smallest detail.

Similarly, ROSEN Challenging Pipeline Diagnostics has the ability to decode the most specific information about your challenging pipelines, thus enabling ROSEN to deliver the all-important data and offer the knowledge necessary for results management and optimal operation of your asset.

For more than 35 years, the ROSEN Group has delivered inspection and integrity services to onshore and offshore pipeline operators around the world. Technology, innovation, and service excellence have made ROSEN the leading pipeline inspection provider with operations in more than 120 countries.

Since the introduction of inline inspection tools (ILI) more than 50 years ago, there have always been pipelines that were considered unpiggable. Typically, it is a combination of various circumstances relating to pipeline design, operating conditions, and/or product properties that prevents a successful inline inspection using traditional methods. At ROSEN, however, we refuse to accept this as a fact. This is why we have dedicated an entire diagnostics division to finding ILI solutions for what we refer to as challenging pipelines.

With its global presence, our Challenging Pipeline Diagnostics Division provides the industry with tailored solutions, backed by ROSEN's comprehensive technology portfolio. Decades of developing and deploying optimized sensor technology for the detection and sizing of geometric anomalies, metal loss, and cracks give us the flexibility to act upon your expectations.

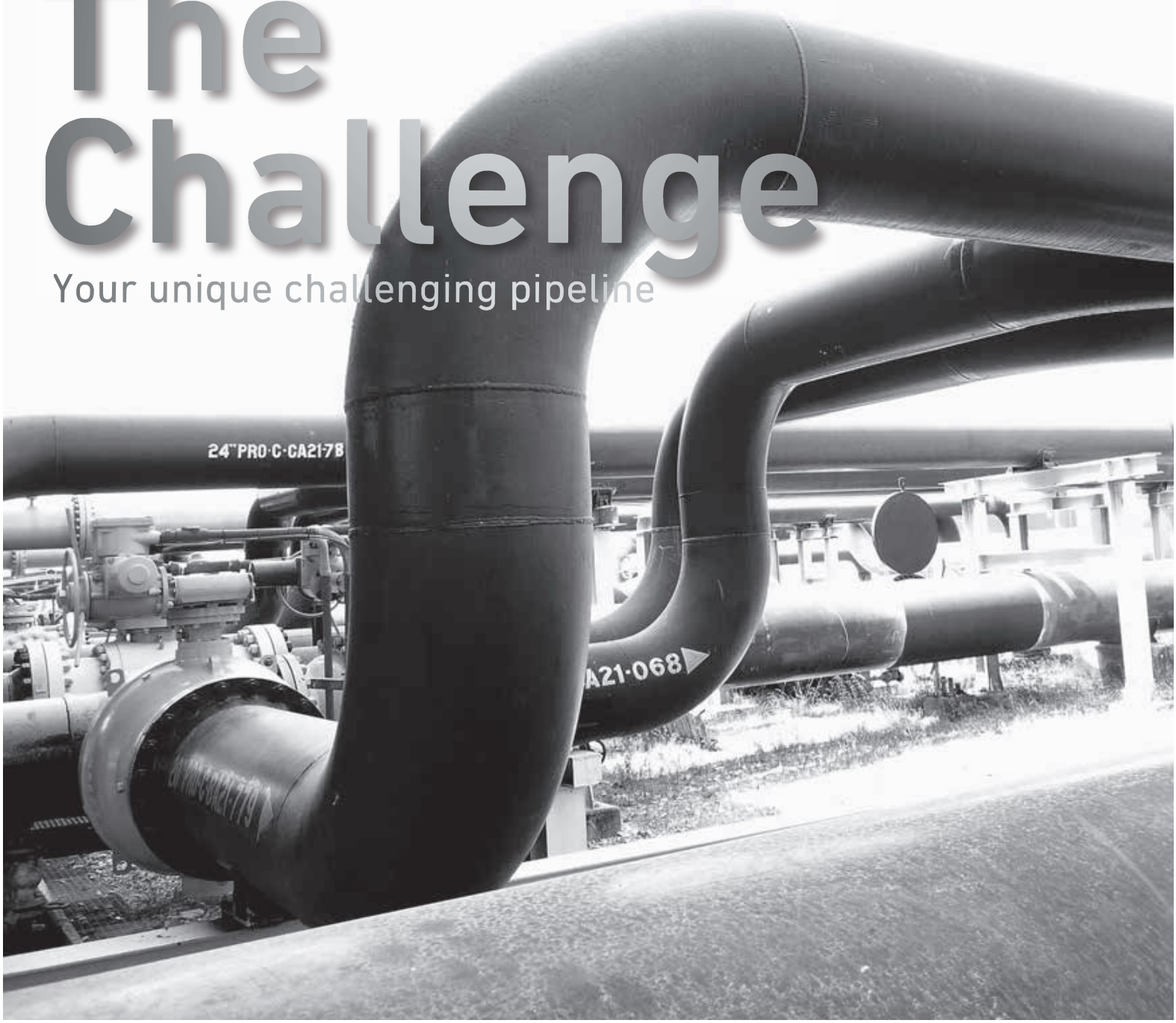
The technologies and products that ROSEN employs are developed and manufactured in-house, and our own experts perform the assessment, preparation, field execution, data analysis and reporting. This allows ROSEN to secure the highest quality of deliverables for our customers.

It is my promise to you, our customers, that ROSEN will always strive to find the best, most flexible solution for your challenging pipeline.

Hermann Rosen

The Challenge

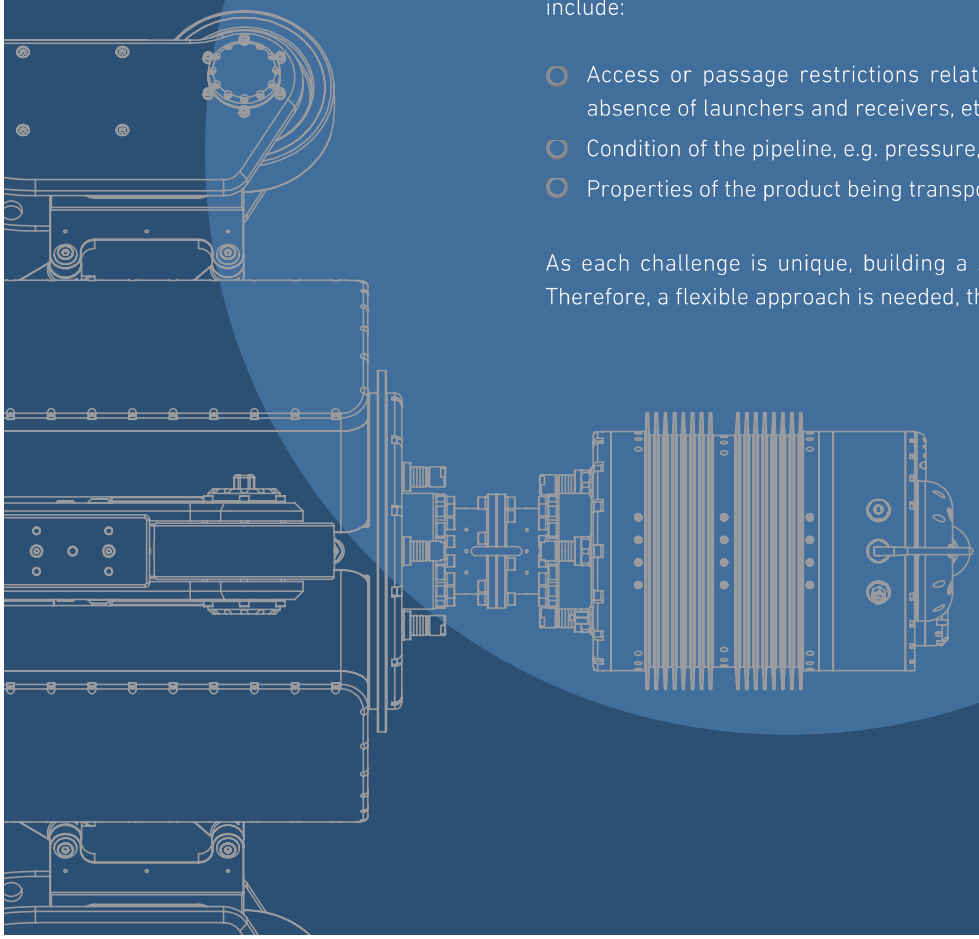
Your unique challenging pipeline



In working closely with our customers, it often becomes clear that it is not simply one hurdle that prevents the use of traditional inspection equipment and technologies. Commonly, the complication lies in the combination of various circumstances which must be overcome. Issues directly arising from these assets often refer to accessibility, negotiability, and operating conditions. Further challenges relate to pipeline cleanliness, tool tracking, and risk mitigation. Though challenges vary from one pipeline to the next, the most common include:

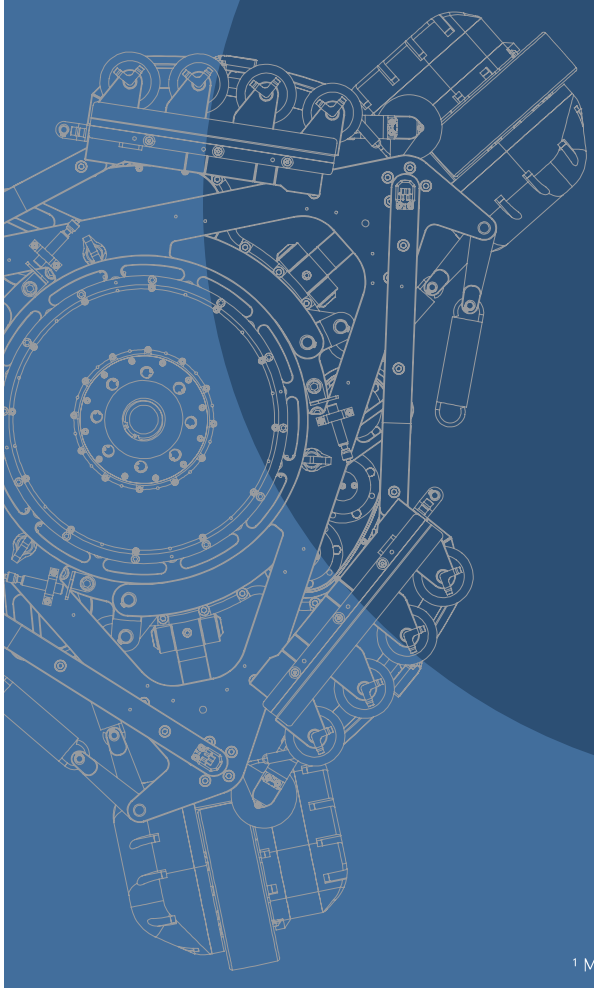
- Access or passage restrictions related to pipeline design, e.g. bends, length, T's, absence of launchers and receivers, etc.
- Condition of the pipeline, e.g. pressure, flow, cleanliness, etc.
- Properties of the product being transported, e.g. temperature, liquid, gas, multi-phase.

As each challenge is unique, building a specific tool for each solution is not feasible. Therefore, a flexible approach is needed, that can be adapted to each individual case.



The Solution

Our Approach



With access to the most advanced technology of today, and the experience resulting from successfully inspecting over 160,000 kilometers of pipelines per year, ROSEN's Solution Experts are well-equipped to explore solutions aimed to tackle a wide range of challenges. Our competence is built on more than three decades of company experience in the inline inspection business, resulting in a wealth of knowledge that allows us to understand the special requirements of successfully inspecting challenging pipelines.

ROSEN's Solution Experts have a clear understanding of the value pipelines represent. Therefore, they will visit your facilities and meet face-to-face with the personnel directly responsible for the operation of the pipeline to review and assess all available information. Detailed analysis of your challenging pipeline enables us to propose the best possible solution together with rated alternatives.

The key to the optimal solution is the "ROSEN Toolbox" approach. It consists of complementing units, such as technologies, methods, and market knowledge, which together enable our Solution Experts to optimally address each challenge. We aim to provide tailored solutions that not only give operators the means to have the pipeline inspected, but also, when required, to provide a comprehensive integrity assessment.

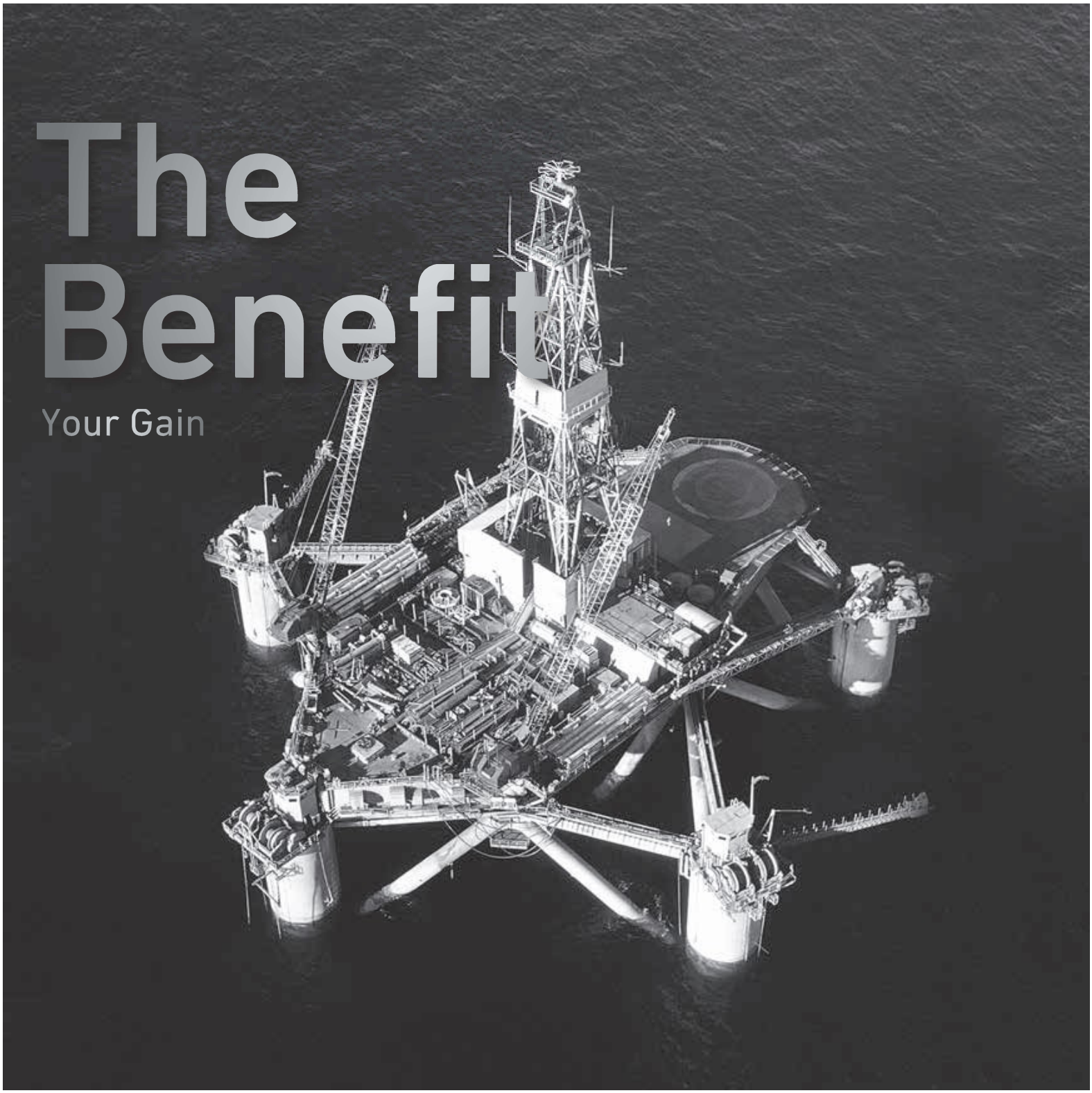
Our solutions are designed using technologies that are developed in-house and further customized to each individual application. This enables us to successfully inspect your pipeline, manage time constraints and project costs, all while delivering the highest-quality data sets under demanding operating conditions. Additionally, we incorporate various fail-safe mechanisms into our solutions in order to minimize the risks associated with inspection. A typical solution package for a challenging pipeline service consists of various elements, including:

- Engineering studies and project management
- Comprehensive pipeline preparation, cleaning and sediment profiling
- The most suitable sensor technology, including MFL, UT, EMAT, EC, etc.[1]
- Specialized tools, including free-swimming, robotic, tethered, etc.
- All necessary auxiliary equipment, including temporary traps, pumps, etc.
- Tool tracking and monitoring systems
- Best-quality data collection under adverse inspection circumstances

[1] MFL: Magnetic Flux Leakage; UT: Ultrasonic Testing; EMAT: Electro-Magnetic Acoustic Transducer; EC: Eddie Current

The Benefit

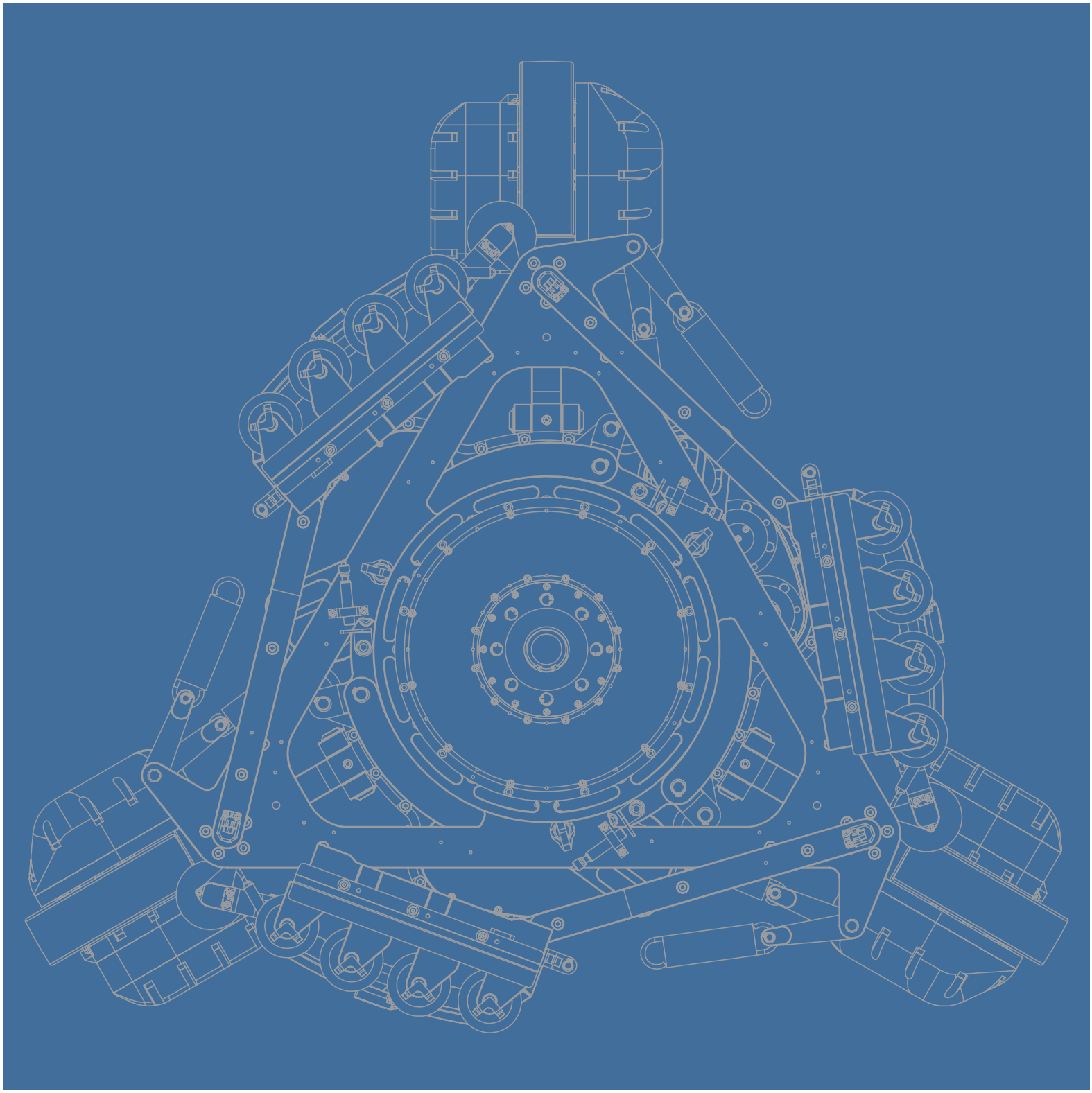
Your Gain

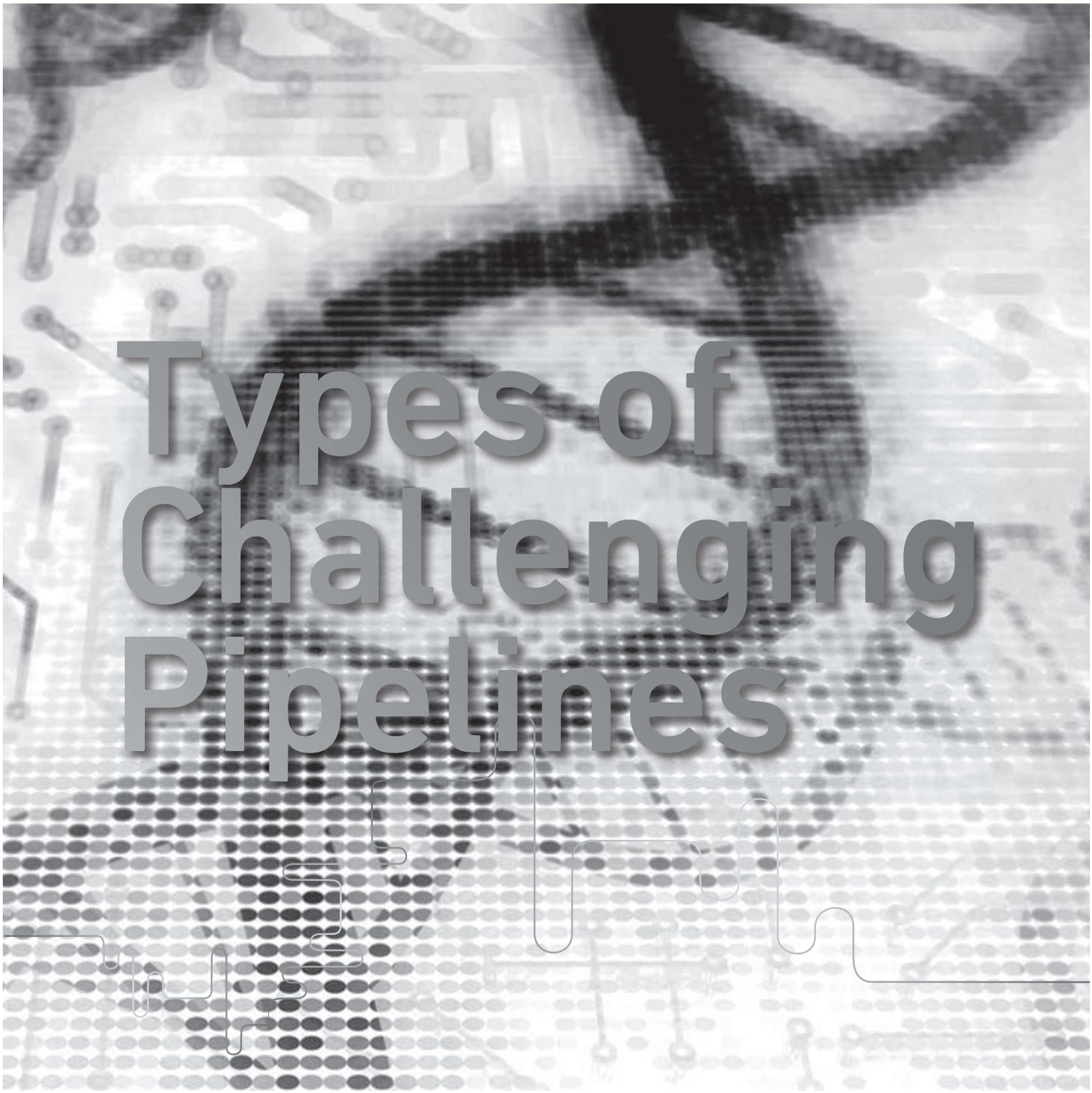


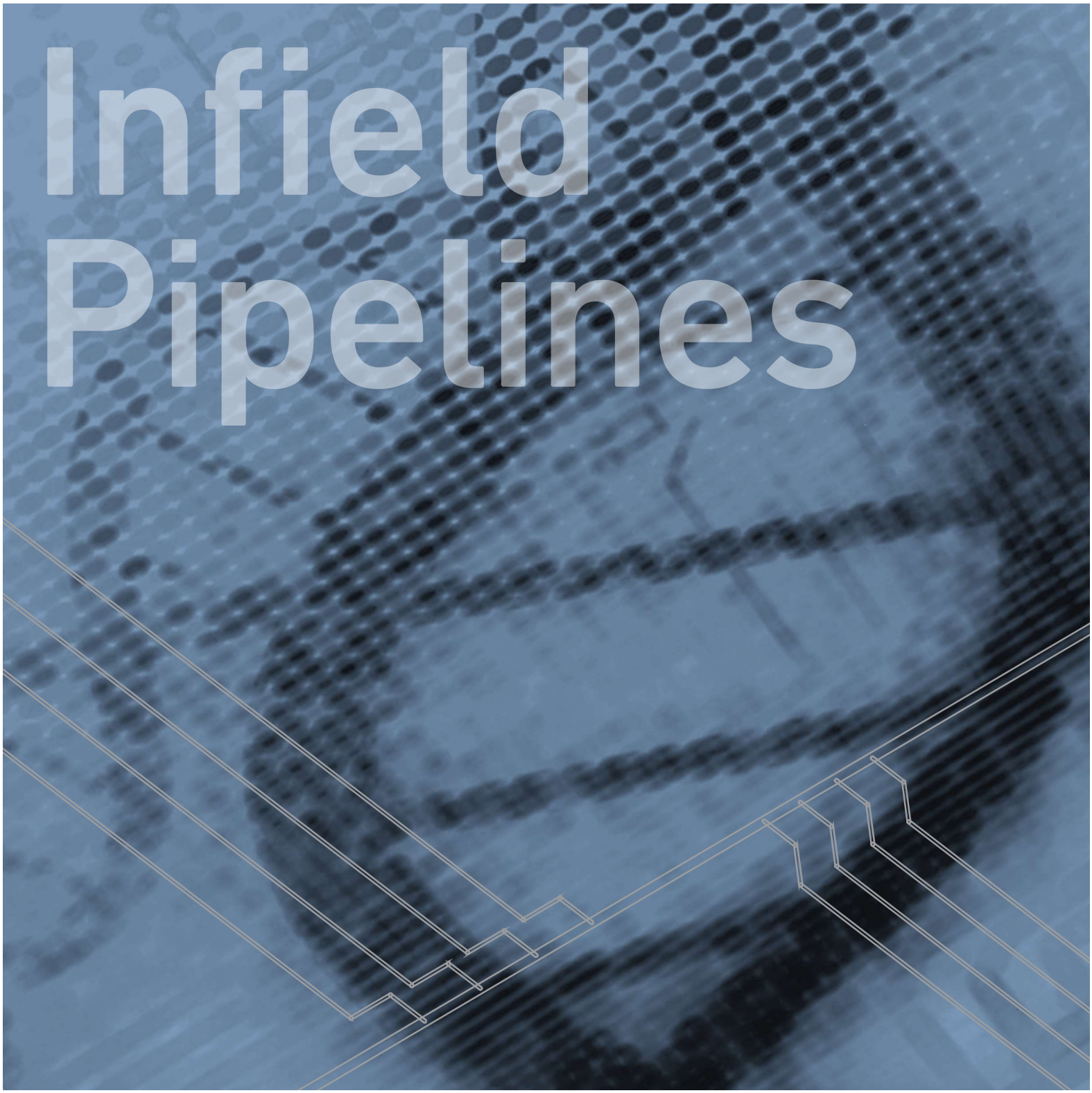
For more than 35 years, ROSEN has provided reliable inspection solutions to pipeline operators throughout the world. Partnering with ROSEN means working closely with our experienced personnel and benefiting from their competence in performing successful inspections. We will help you achieve your goals by:

- Maximizing pipeline uptime and sustaining or even increasing product throughput
- Complying with current and upcoming safety standards and regulations
- Managing public perception in the pursuit of zero incidents
- Extending asset lifetime
- Safeguarding the environment
- Optimizing maintenance processes

This is our way of creating ultimate value for our customers, while making ROSEN the most reliable, competitive and flexible solutions provider — a partner you can trust.




Types of
Challenging
Pipelines


Infield
Pipelines

Infield, or gathering, pipelines transport fluids or gas from the well area to a point of collection. As fields age, low-pressure operating conditions can present significant challenges. These systems may experience extreme temperatures when transporting single or multi-phase products. Infield pipelines may carry debris along with a mixture of oil, gas and water. Though many obstacles exist, particularly in low-pressure or low-flow lines, overcoming speed excursions during inspection is one of the main challenges. Other inspection challenges relating to these assets include:

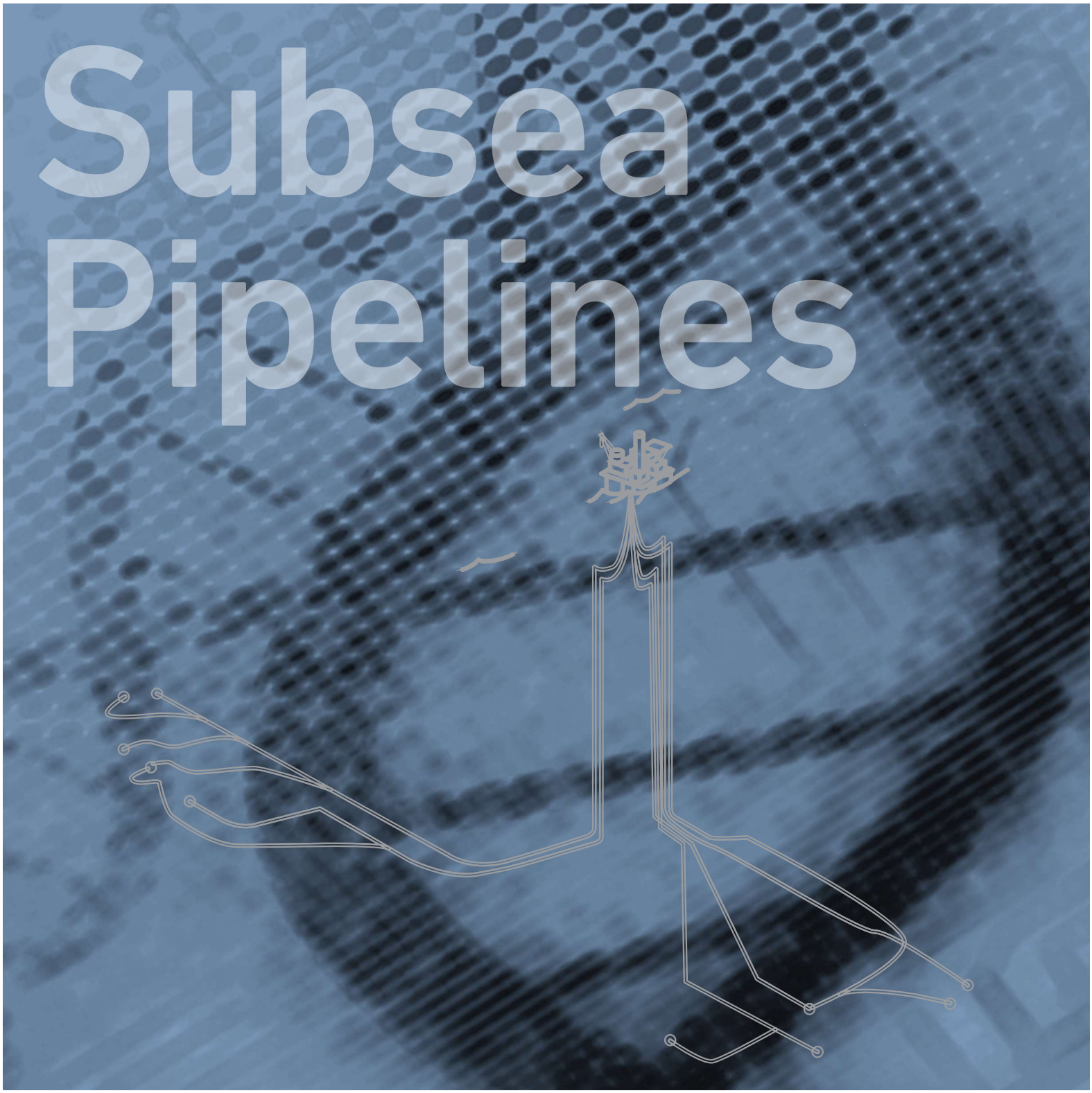
- On and offshore environments
- Single or no access
- Pipeline designed with no consideration for internal inspection
- Wide range of wall thickness
- 1.5D bends
- Unknown cleanliness conditions
- Single, low, or unidirectional flow, where reversal is not possible
- Temperature variations
- Wide range of operating pressures

Facility and Process Pipelines

Facility and process pipelines are used worldwide for efficient and safe product transfer. These pipelines transport crude oil, refined product, natural gas, chemicals, and lubricants, among other products in refineries, terminals, processing plants, etc. Not only do these pipelines often operate in high-consequence areas, they are also within close proximity to other systems. Facility and process pipelines typically travel within a facility or connect different facilities, thereby leaving the controlled area within the fence. The original design plans for these pipelines rarely considered the need for internal inspection. Facility and process pipelines often present the following challenges:

- Single or no access
- Dual or multi-diameter
- Wide range of wall thickness
- 1.5D, miter, and back-to-back bends
- Cleanliness
- Low or no flow
- Flow reversal not possible
- Highly reactive and/or hazardous mediums

Subsea Pipelines

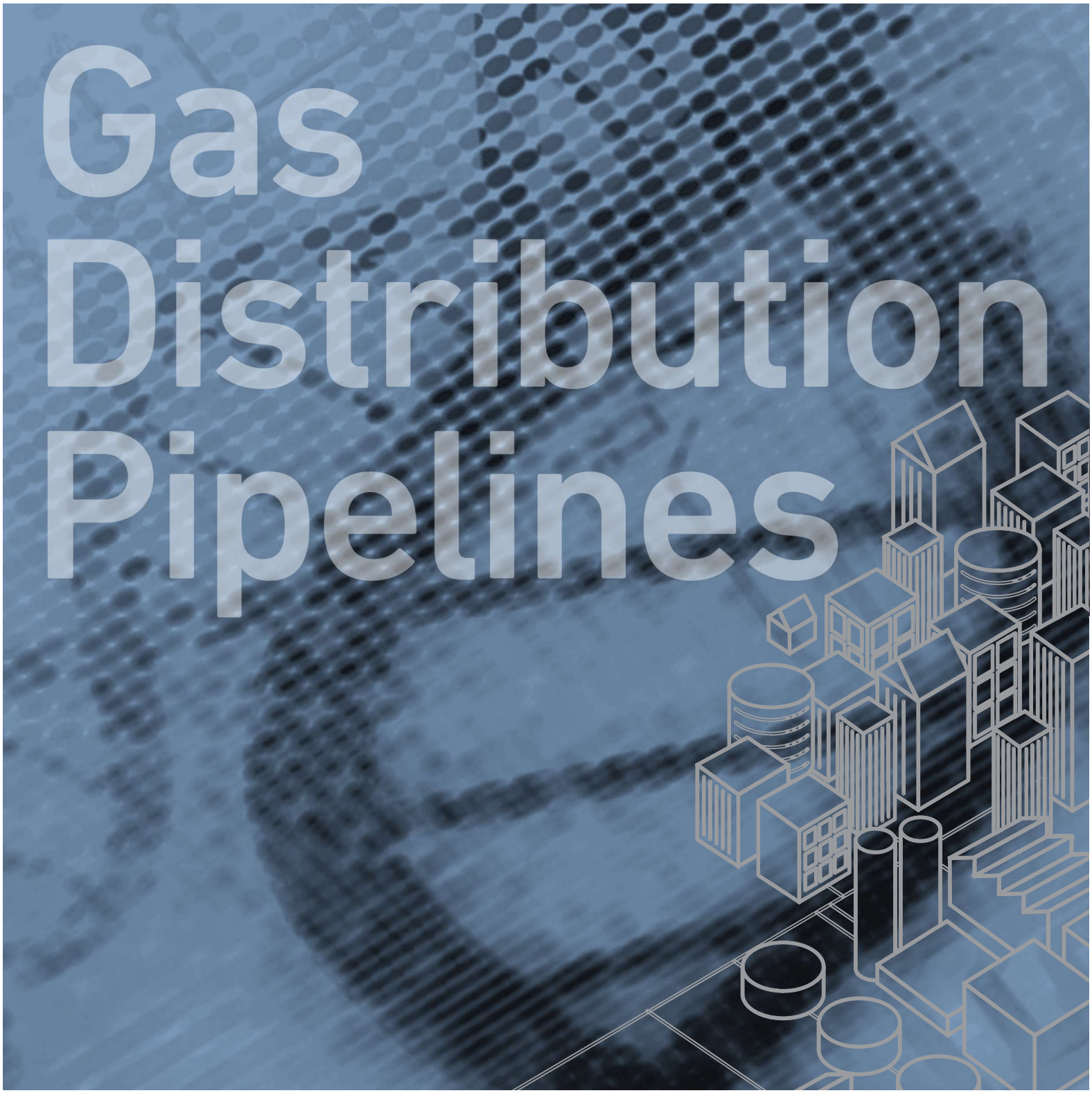


Pipelines can be submerged as far as thousands of meters below the sea, redefining extreme conditions. Their operation is typically coupled with great environmental risks, high costs, and harsh operating conditions. In addition, they are increasingly finding their way into the public eye. ROSEN's Solution Experts are extremely well equipped to cope with subsea pipelines' operating conditions and ensure inspections of the highest standards. Some of the challenges include:

- Wide range of wall thicknesses, often 26 mm or higher
- Tight bends and/or mechanical deformation
- Single or no access for internal inspection systems
- Unbarred offtakes
- Low flow and/or unidirectional flow
- Dual- and multi-diameter design
- Extremely high pressure, up to 550 bar

These assets often transport crude oil, gas, refined or multi-phase products, which are accompanied with their own set of challenges, including heavy debris or sour service. Subsea pipelines are often required to be inspected with minimal disturbance to normal operations.

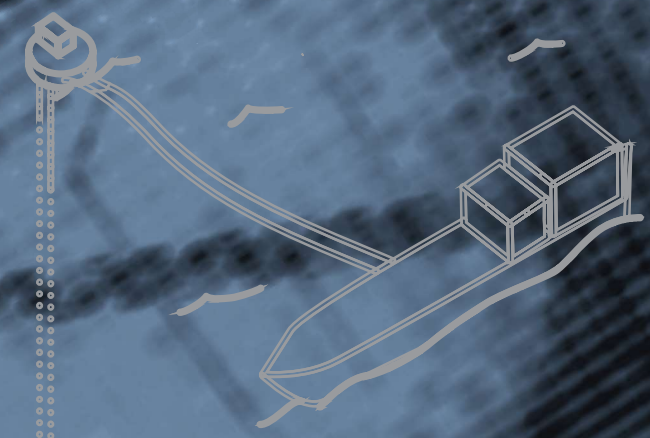
Gas Distribution Pipelines



These systems often contain several interconnected pipelines with varying diameters, and are generally used to transport gas within the midstream or downstream sector. They often distribute gas at a low pressure to other terminals or industrial facilities, both within and outside of urban areas. The delicate balance between supply and demand of product relies on the efficiency of these assets. In addition, many of these pipelines are within close proximity of densely populated areas. Although gas pipelines comprise the majority of pipeline networks, they nonetheless often present unique inspection challenges, including:

- Dual or multi-diameter
- 1.5D and back-to-back bends
- Limited to no accessibility
- Unidirectional operations with low flow and/or pressure
- Heavy deposits such as black powder
- Unbarred offtakes

Loading Lines



Tanker loading/unloading lines are unique pipeline assets in the oil and gas industry. In many cases, these pipelines connect shore-based installations to a subsea pipeline end manifold (PLEM). The PLEM is connected to the surface buoy by subsea hoses. The mono-buoy is then connected to the tanker using floating hoses to accomplish the loading or unloading process. As these lines are the point of export and/or import of hydrocarbons, and in most cases there are no alternative means, they are often deemed a critical element in an operator's network. Loading lines often present the following challenges:

- Single access
- Dual or multi-diameter
- Wide range of wall thicknesses
- 1.5D and miter bends
- Unidirectional, low or no flow
- Flow restrictions based on port loading and offloading schedules
- Pipeline cleanliness
- Coastal environment
- Unusual pipeline design

Your ROSEN Group worldwide

3 decades of experience

More than 2,000,000 kilometers of pipeline inspected

7 technology and research centers developing new technologies

90% employees with technical backgrounds

Contact

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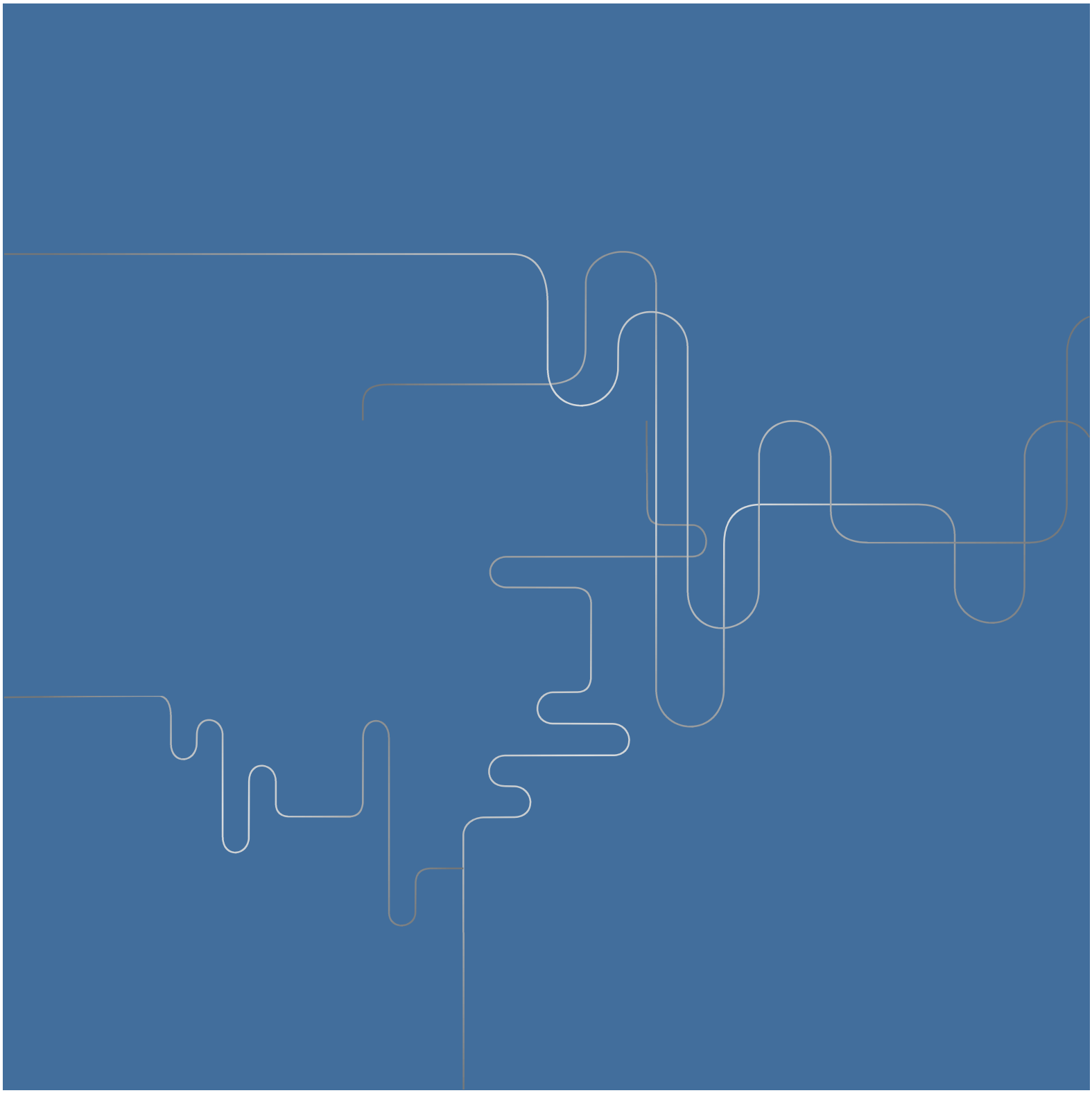

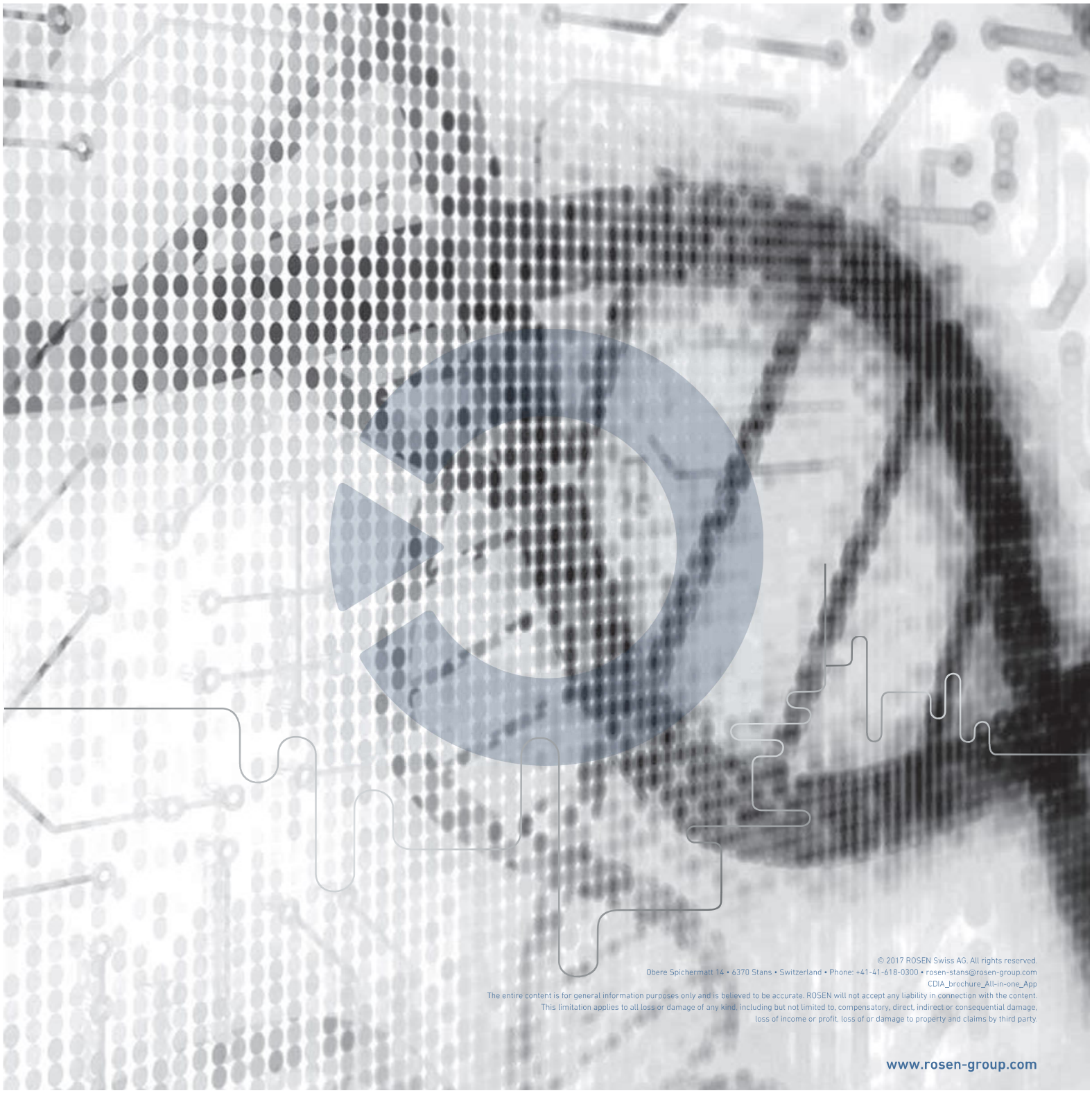

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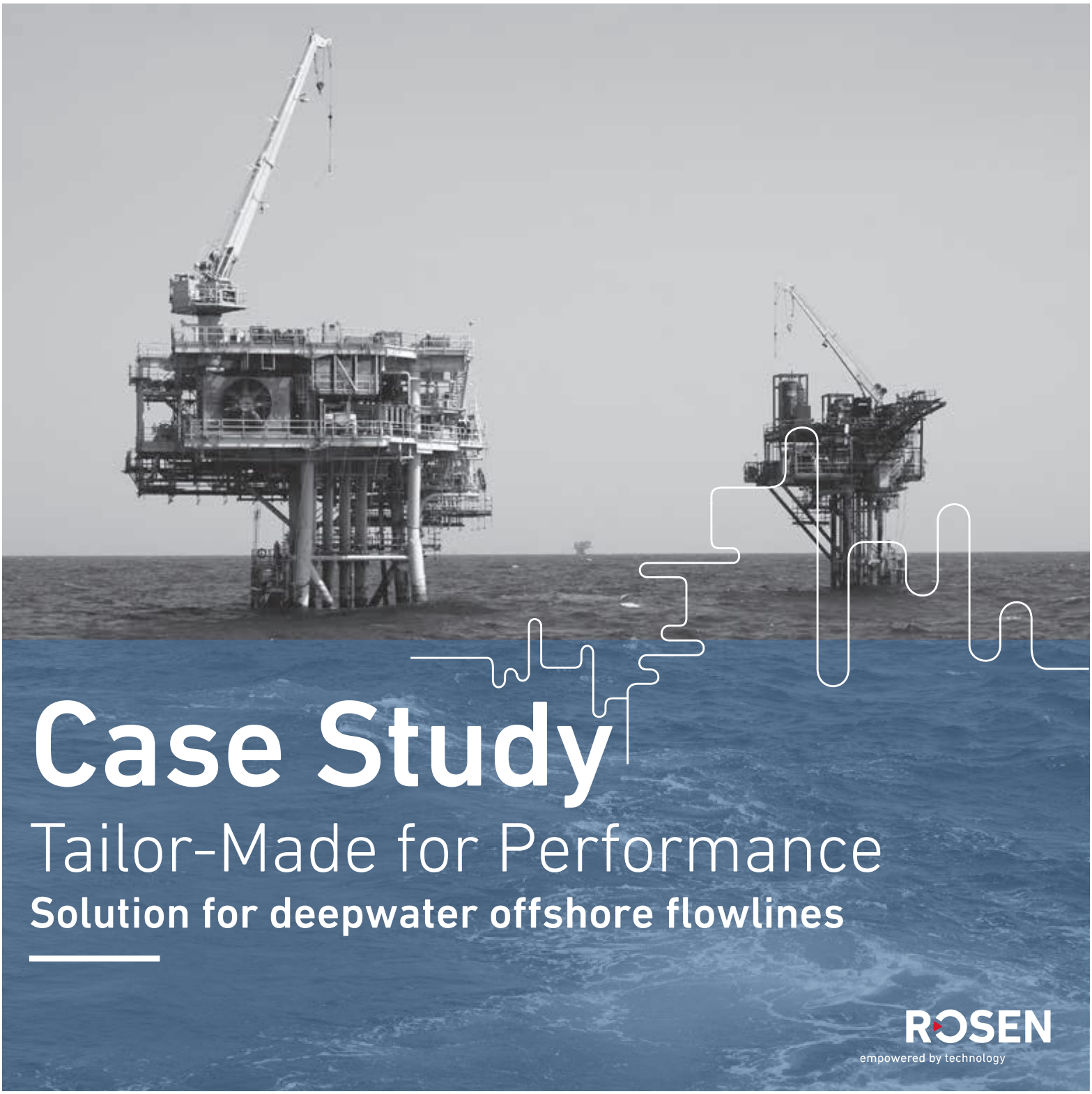

Case Study

Tailor-Made for Performance

Solution for deepwater offshore flowlines

ROSEN

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The Challenge

Two oil field flowlines located in west Africa 120 km offshore, in water depths of 1100 m, needed to be inspected for corrosion. The customer requested an inspection for two 8 km flowlines, which have 10/12" dual diameters and wall thicknesses from 12.7 mm to 31.6 mm. Under ideal circumstances, the customer could have inspected the complete 16 km pipeline system in one run. The tool would be launched into the first flowline, sent through a pigging loop at the Pipeline End Manifold (PLEM) into the second flowline, and received back on the deck of the Floating Production Storage and Offloading vessel (FPSO). However, ROSEN engineers were informed by the pipeline operator of the possibility that a defective valve on the PLEM wouldn't open completely, meaning that an inspection tool might not be able to pass through the PLEM. The uncertainty on the valve's functionality, along with the deep-water offshore environment, the heavy pipe wall thicknesses, and the continuous operation demands, presented a challenging situation that required a unique solution.

Our Solution

The uncertainty of the valve's position was a critical issue for the pipeline operator and it was absolutely essential to complete the full inspection in one shutdown. Therefore, ROSEN proposed an inspection solution that consisted of bidirectional cleaning and gauging tools, as well as a bidirectional UT solution.

If the results of the cleaning and gauging process showed no damage to the tools, then the inspection would be performed in a unidirectional run. However, if the gauge plate returned with damage, indicating a partially closed valve or reduced diameter, the pipeline would be inspected bidirectionally by sending the tool through the first flowline to the PLEM, and then reversing the flow to pump the tool back to the FPSO. This process would be repeated for the second flowline, but only one shutdown would be required for the entire operation.

A tailor-made 12" bidirectional (BiDi) UT tool that met the passage and corrosion inspection requirements was developed. The unique design of the BiDi tool ensures that the data quality is equal to that of ROSEN's standard UT tools, thus providing the high-resolution data quality required to ensure the pipeline's integrity. The tool was subjected to pump testing through a simulated pipeline configured to have similar diameters, wall thicknesses, and bend radii as these flowlines.

The inspection campaign began by sending the cleaning and gauging tools through the pipeline to determine whether they could pass the valve. After launching the gauge tool into the pipeline and receiving it again, the gauge plates confirmed that the valve was fully open at the time of inspection. Therefore, the BiDi UT tool was launched into the pipeline and completed the full inspection through the pigging loop in one unidirectional run. A detailed analysis of the recorded data was performed by ROSEN engineers and the final results were delivered to the pipeline operator to the satisfaction of all parties.

Your Benefit

Maximized Uptime The solution provided flexibility in allowing both a unidirectional or bidirectional inspection, whatever the situation required. This operational flexibility kept the downtime, and any production losses for the client, to an absolute minimum.
Compliance Complete data sets allowed for a full understanding of the pipeline condition and the ability to take measures for its integrity management. This ensures compliance with safety standards and regulations.
Minimized Risk Exposure ROSEN's bidirectional approach assures the tool can be removed from the pipeline at any time, hereby minimizing the operational risk and effectively guaranteeing operational safety.

challengingdiagnostics@rosen-group.com

Case Study

Geneva Airport

Tailored approach for jet fuel feeder line

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The Challenge

In this unique case, the challenging assets are two 6" feeder lines that supply fuel to airplanes at the Geneva Airport through a hydrant system from a tank farm. This system is largely considered unpiggable due to low points where water is separated and removed on a weekly basis. The last section of pipe going to the tanks, located on the airport grounds, is located in close proximity to airplanes. Furthermore, these lines cross airport taxi lanes, which consist of extremely thick concrete. These pipelines' integrity must be assessed in order to establish an integrity management plan and avoid the costly construction associated with the replacement of these feeder lines.

The objective of the inspection of these assets was to identify the integrity status of the pipeline by measuring internal and external corrosion. The challenges for this case were abundant, including the following factors:

- No traps were available
- Only one point of access was feasible
- Limited negotiability due to the presence of miter bends

In addition to these unique pipeline traits, the customer required a series of boundary conditions to be met, including; no interference with airport operations, no contamination of product, no daytime-hour access on site, and full inspection coverage was required.

Our Solution

ROSEN solution officers worked closely with the customer to tailor a solution package that would allow for the successful inspection of these feeder lines. Technical clarifications resulted in an agreement to use a medium propelled bidirectional UT inspection system. The pipeline was also isolated from the system, as jet fuel supply was guaranteed via the second parallel line. The solution package consisted of a variety of adaptations, including:

- The installation of a temporary trap
- System tracking as the tool passed critical installations
- Propulsion method created by using pumps from the hydrant system
- A loop installed at the tank farm allowing the tool to be propelled back using the pumps from the hydrant system
- Flow controlled through a reduced diameter ball valve and flow meter

ROSEN solutions officers had recently completed the development of the world's shortest 6" bidirectional UT inspection system, and this was a great opportunity for its debut. The project was executed within the agreed time frame and without any accidents or incidents. Additionally, the quality of the data collected met the expectations of the customer.

Your Benefit

Cost Effective The tailored approach required minimal construction, with only minor temporary pipe modifications required. In addition, tool launching and receiving were done by hand, avoiding the need for equipment. Furthermore, no digs were required.

Compliance Complete data sets allowed for a full understanding of the pipeline condition and the ability to take measures for its integrity management. This ensures compliance with safety standards and regulations.

Safety The bidirectional approach ensures fail-safe measures were taken into consideration, and the tool could be reversed at any time if needed. Securing the safety of the asset, operators, and surrounding environment.

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Case Study

Innovative Robotic Solution

Inline inspection of gas storage laterals

ROSEN

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The Challenge

Operators have to contend with many obstacles in order to obtain high-resolution data for their pipelines. The inspection of gas storage laterals is no exception. Though they vary in complexity, with each lateral containing its own unique characteristics, the following obstacles were consistent in each gas lateral presented in this challenge:

- No launchers and no receivers
- Single access point
- 10" lines connect to 20" trunk line
- Limited flow conditions available

Our Solution

After all alternative solutions were evaluated, it was determined that a bidirectional MFL-based crawler solution best suited the challenges present in these storage laterals.

Within five months, ROSEN designed, manufactured, assembled and tested the new self-propelled inspection solution. The robotic solution tool consists of a crawler unit based on an innovative CAM approach. The cams are able to generate enough traction to ensure greater passage capability, safely negotiate various obstacles, all while towing a high-resolution low-friction MFL unit.

As with all solutions, a well-designed fail-safe system is essential; what goes in the pipeline must come out. For this application, ROSEN's Solution Experts utilized a collapsing "gripper" failsafe and a tethering retrieval unit.

The solution contained innovative elements such as:

- High-resolution MFL technology capable of delivering 100% data coverage
- Bidirectional/low-friction magnetizers
- Onboard power storage
- Visual monitoring
- Power-consumption monitoring
- Sensor detection of T's

Your Benefit

Performance

High-resolution complete data sets allow for a full assessment of the storage laterals' condition and play a vital role in the integrity management plan. This ensures compliance with safety standards and regulations while extending the asset's lifetime. Due to the small equipment footprint and quick setup on-site, multiple inspections can be completed within one day, allowing for optimal operational effort.

Cost-effective

The bidirectional approach avoids the need for costly pipe modifications at the interface between trunk line and lateral as the same location is utilized for insertion and retrieval of the inspection system. As the crawler propels itself, no further field services are required for the execution of the work.

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Case Study

No-Compromise Solution

Ultra low flow natural gas pipeline

ROSEN

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The Challenge

For several years, the ROSEN Group has worked closely with an Italian natural gas infrastructure company to support the integrity assessment of their distribution network. Most recently, ROSEN has been asked to provide an inspection solution for a 16" pipeline that supplies product to customers through various offtakes distributed along the pipeline. The gas velocity is stronger at the beginning of the pipeline but then reduces after every offtake, reaching a velocity as low as 0.1 m/s. The specific pipeline operating conditions ruled out the possibility of applying a standard approach.

Our Solution

The pipeline operated at approximately 45 bar pressure, hence excessive speed variations that are typically observed during the inspection of low pressure lines were not to be expected. Instead, the risk was that a tool become stationary due to insufficient sealing. Even the smallest leakage over the tool can create an unwanted bypass and cause the tool to be lodged. The solution therefore concentrated on designing a customized pull unit which provided optimum sealing in all diameters present. In addition, a low-friction magnetizer was used to reduce the risk of a stationary tool due to bypass. Furthermore, the total inspection time was extended by installing additional batteries in the pull unit.

As with every Challenging Pipeline Diagnostics project, one of the key golden rules is: what goes in must come out. ROSEN's Solution Experts were confident that the tool would come out. However, given the innovative nature of the inspection, it was agreed that in the event of a stationary tool, a temporarily increased flow would be created by depressurizing the line downstream of the tool.

In order to confirm free passage for the ILI tool, a run was made first with a gauge tool equipped with a Pipeline Data Logger (PDL), which is a transmitter for accurate tracking and locating of equipment. Assessment of the gauge tool confirmed free passage for the MFL inspection system. Furthermore, the differential pressure of the PDL revealed no unexpected run behavior. However, the total run time of 168.15 hours revealed that the flow conditions were more challenging than expected: the gas velocity in the last 6.5 km was as low as 0.01 m/s.

ROSEN accepted the challenge nevertheless and decided to launch the MFL system. The tool was received 145 hours later. The runtime, as well as the system's condition, indicated that excellent sealing was achieved. Unfortunately, the data was not complete due to electronic failure resulting in sensor loss. A rerun was recommended in order to deliver the contractually-agreed data quality.

The rerun was executed, and the MFL system was received two days later in good condition. The inspection was successfully completed within the pre-agreed contractual requirements.

Your Benefit

Through the successful inspection, valuable integrity data has been collected which allows for the continued safe operation of the pipeline. Compared to a conventional solution, ROSEN's low-flow solution did not impact the operation of the pipeline and no compromises were made on the quality of the inspection data. In addition, the in-service inspection allowed for greater scheduling flexibility, as the inspection could be carried out with less dependency on production planning.

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Case Study

Black is Black

Low pressure solution combined with a heavy duty cleaning campaign

ROSEN
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The Challenge

In most circumstances, a customer request for a 14" pipeline inspection over 15 kilometers which meets ROSEN's high-resolution MFL specifications is one that is executed successfully countless times. In this case, however, there were multiple unique challenges to overcome, including:

- Heavy black powder deposits
- Low pressures of approximately 15 bar
- First-time inspection resulting in many unknowns

Black powder is a solid deposit found in gas pipelines which becomes present through a variety of sources, including mill scale from the pipe manufacturing process, internal pipeline corrosion, or even directly from gas gathering systems. Without the much needed pre-inspection cleaning, the low-pressure inspection technology could not be properly applied. The operator's goal was to complete a corrosion survey that met all government regulations.

Our Solution

Initial cleaning runs indicated the line was clean enough to commence the geometry service, which includes technology based on eddy current combined with a specially modified low-pressure kit. Although the geometry inspection went well, the tool was retrieved showing still a significant amount of debris present in the line, and therefore a more vigorous cleaning approach was needed.

A customized heavy-duty cleaning tool was devised using the ROSEN Toolbox method. The tool was adapted from an MFL-based system, fitted with fewer magnets than a typical tool, and descaling cups were added to combat the low-pressure operating conditions. Hereby creating a completely tailored system from existing components, which functioned as expected.

Following the successful cleaning campaign using this specialized tool, the on-site team was convinced the metal loss inspection could take place with a low-friction MFL-based technology. In the case of low-pressure pipelines, a dominant challenge is to overcome speed excursions which normally occur during inspection runs as a result of passing bends, wall thickness variances, welds, or the presence of debris. In this case, the MFL-based system was optimized for these conditions by utilizing the following elements:

- Low-friction wheeled magnetizer yokes
- Enhanced cup design for reduced and constant friction
- Customized yoke support system
- Friction reducing odometer unit
- Ultra-compact and light weight design

Your Benefit

Cost Effective The tailored approach allowed for optimized adaptations in regards to cleaning and inspecting the pipeline. In addition, the solution was completed during regular operation with no loss in production or impact on operations.

Compliance & Safety Complete data sets allowed for a full assessment of the pipeline condition, and played a vital role in the pipeline integrity management plan. This ensures compliance with safety standards and regulations.

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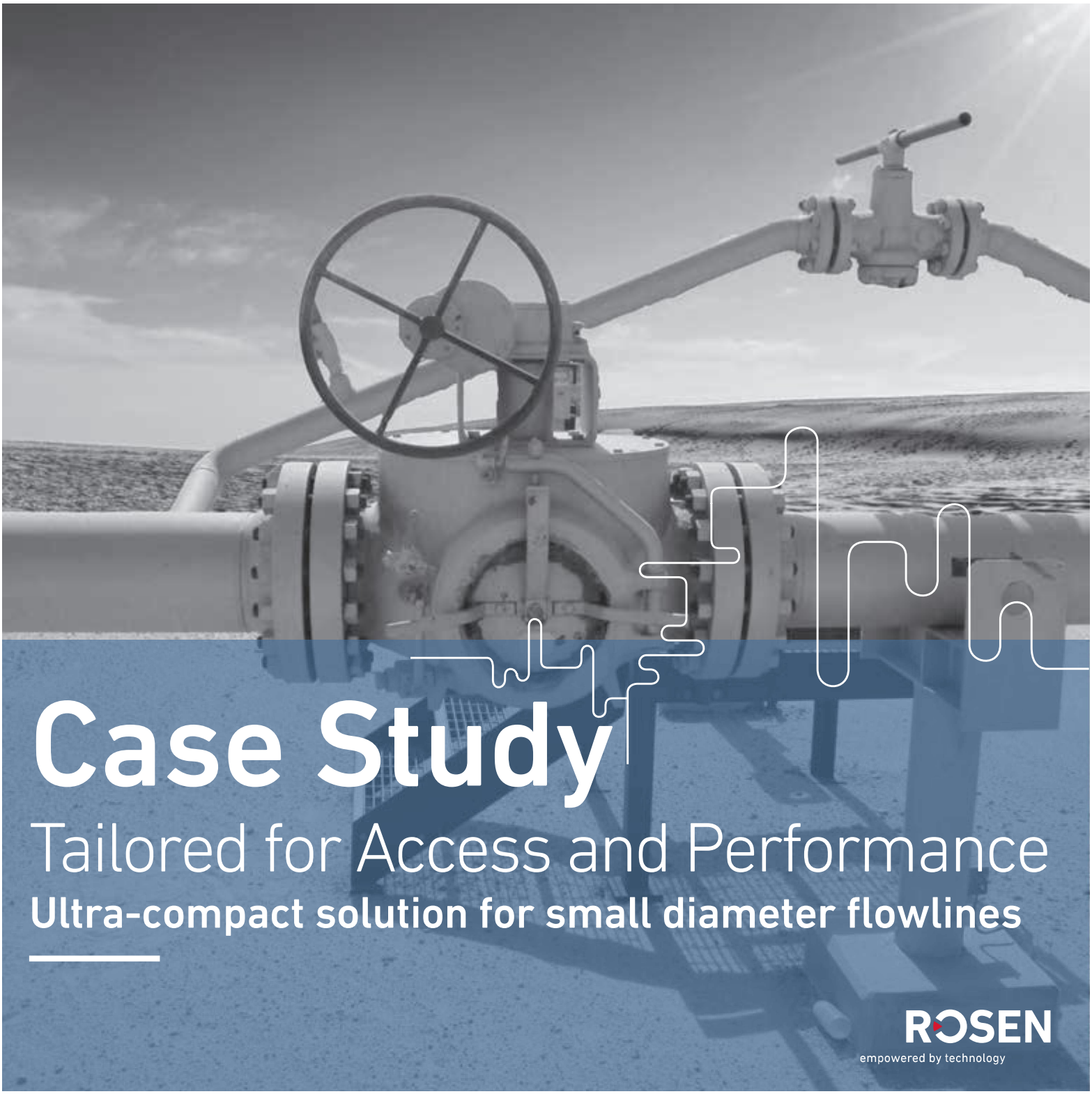

Case Study

Tailored for Access and Performance

Ultra-compact solution for small diameter flowlines

ROSEN

empowered by technology

The Challenge

Operators are forced to face a variety of complex challenges within pipeline networks, especially those relating to inline inspection. Typical challenges include mechanical design, operating conditions, and the properties of the product being transported, however, in multi-phase infield pipelines with 3-way ball valve access, even more challenges are present, including:

- Restricted access only available in the form of a 3-way valve
- Tight bends throughout pipeline length
- No pipeline architectural information
- Flow and pressure fluctuations (well-flow characteristics)
- Multiphase medium
- Heavy debris
- High temperatures and velocities

In addition to the challenges at hand, the inspections are preferably carried out during regular operation.

Our Solution

When faced with these challenges, it is clear that no existing or conventional solution was applicable. ROSEN's Solution Experts therefore began developing a completely new solution out of existing elements.

A long list of components needed to be integrated into the tool, these components consisted of: batteries, seals, magnetizer and sensors, system controller, data acquisition and storage unit, computer interface, and odometer system. Normally, this would result in an over two-meter-long unit. Instead, ROSEN experts developed an ultra-compact ILI tool equipped with proven MFL technology which only requires moderate cleanliness. The customized solution package consisted of:

- Integrated electronic and battery units inside the magnetizer body
- Strong and flexible magnetizer
- High-resolution MFL sensors
- Large polyurethane buffer for the protection of the tool and valves
- Short design for optimum flexibility and passage
- Bidirectional capability and low minimum passage requirement
- External referencing system
- Launching and receiving equipment

Your Benefit

Maximized Uptime

Pipeline modifications are not required, no liquid filling or nitrogen pumps are needed, and hydro-testing can be avoided. Furthermore, the inspection can be completed within half a day, after preparation work is completed, limiting the interference with normal operation.

Cost Effective

The lightweight solution also limits the need for costly onsite support equipment, pipeline modifications, and manpower.

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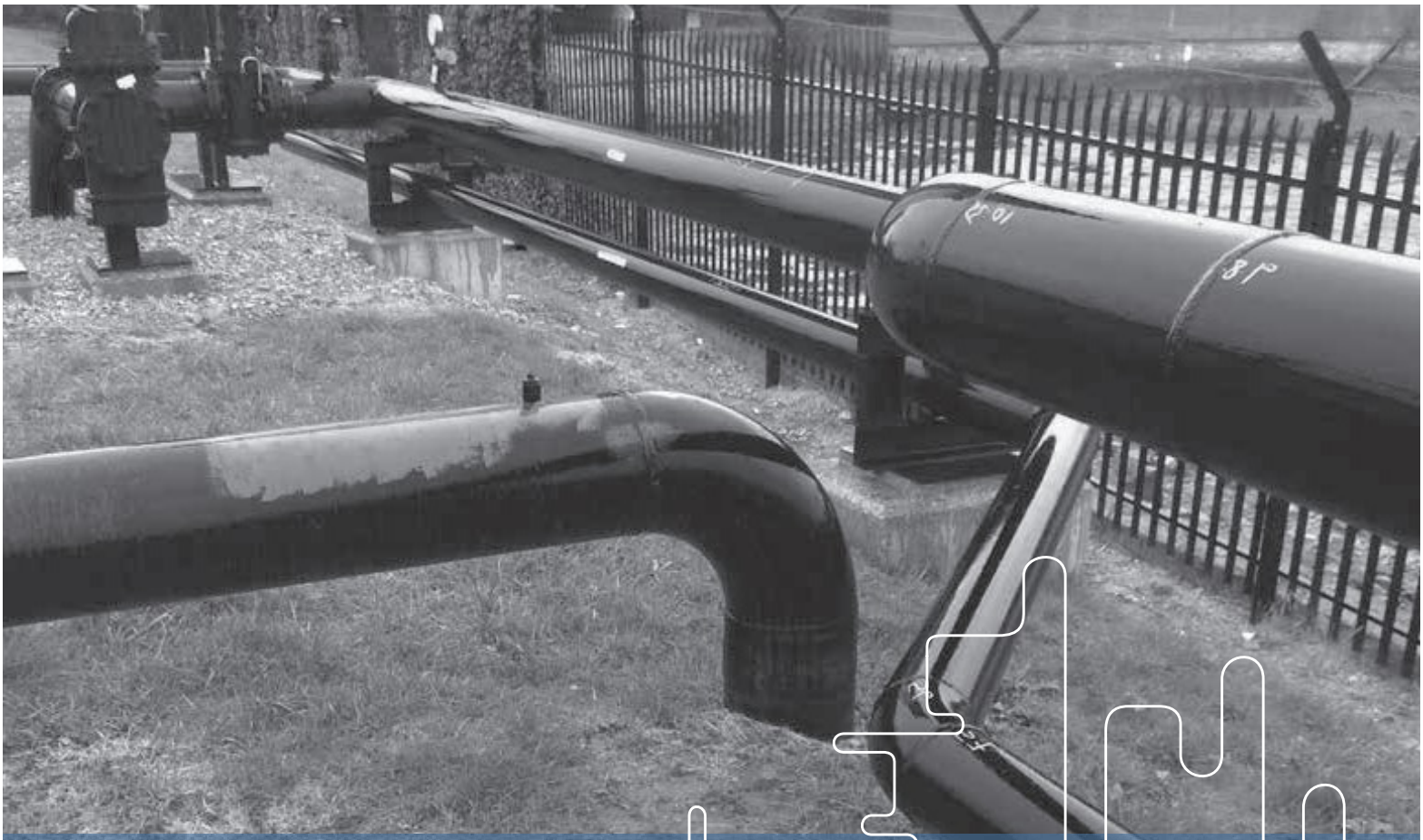

Case Study

No Flow Required

Inline robotic mfl solution delivers fast inspection results

ROSEN
empowered by technology

The Challenge

A 10", 600-meter-long line, built in 1961 to transport fuel for use in aircraft turbine engines, was in need of inspection. The pipeline had previously received an external inspection using long-range ultrasonic testing (LRUT), and two defects were detected. The pipeline was then taken out of commission. The operator's goal was to complete a full inline corrosion inspection so that it could eventually be returned to service. The pipeline posed several physical challenges, one being the lack of launching or receiving facilities, another being the out-of-service condition, due to which there was no flow of medium to propel the tool. In addition, the pipeline has 1.5D bends, and the inspection needed to be performed within two months of the initial inquiry.

Our Solution

Following an onsite visit, several inspection options were evaluated. Considering the main challenges, ROSEN and the customer concluded that a self-propelled inspection solution would be the most suitable approach. An advantage of a self-propelled solution is that it does not require the line to be pressurized, thus reducing the risk of liquid spills from leaks.

The self-propelled inspection solution, a tailor-made MFL unit configured to offer the same inspection capabilities as free-swimming devices, was adapted to ensure the highest-possible performance and to address specific issues such as the higher drag created by the magnetizer touching the pipe wall and the adhesive forces resulting from the magnetic field. To overcome these particular challenges, a powerful propulsion system was integrated, which consisted of two crawler units on either side to create pull in either direction. The unit was based on cams which hold onto the pipe and provide sufficient force to pull all remaining units.

The decision was made to control the tool via a tether so a live image of the pipe interior was available throughout the inspection period. The tether also served as a recovery option. In the event that the tool would be unable to back out of the pipeline on its own, the cams would collapse and the tool could then be pulled out via the tether.

ROSEN personnel worked closely with the customer to arrange for the inspection to be performed as soon as possible to meet their timeline. Because the tool is bidirectional and self-propelled, only one entry point was required. Once on site, ROSEN's scope of work included purging the line with nitrogen to ensure a safe working environment and then performing the actual inspection.

Due to the urgent need to put the line back into service, ROSEN equipment and personnel were mobilized two days after the contract was awarded. The fieldwork was completed eight days later, and the final inspection report was delivered within three weeks. The project was successfully performed within the pre-agreed time frame and without incidents.

Your Benefit

Fuel Service The MFL inspection data gives the operator a complete overview of the pipeline's status with regard to corrosion. Armed with this information, the operator can now make the correct integrity management decisions to return the pipeline to service so that it can operate safely and efficiently.

Performance The site work was completed within two months of the first inquiry from the customer and within ten calendar days of signing the contract. The rapid service delivery allowed the operator to quickly assess the integrity of their pipeline.

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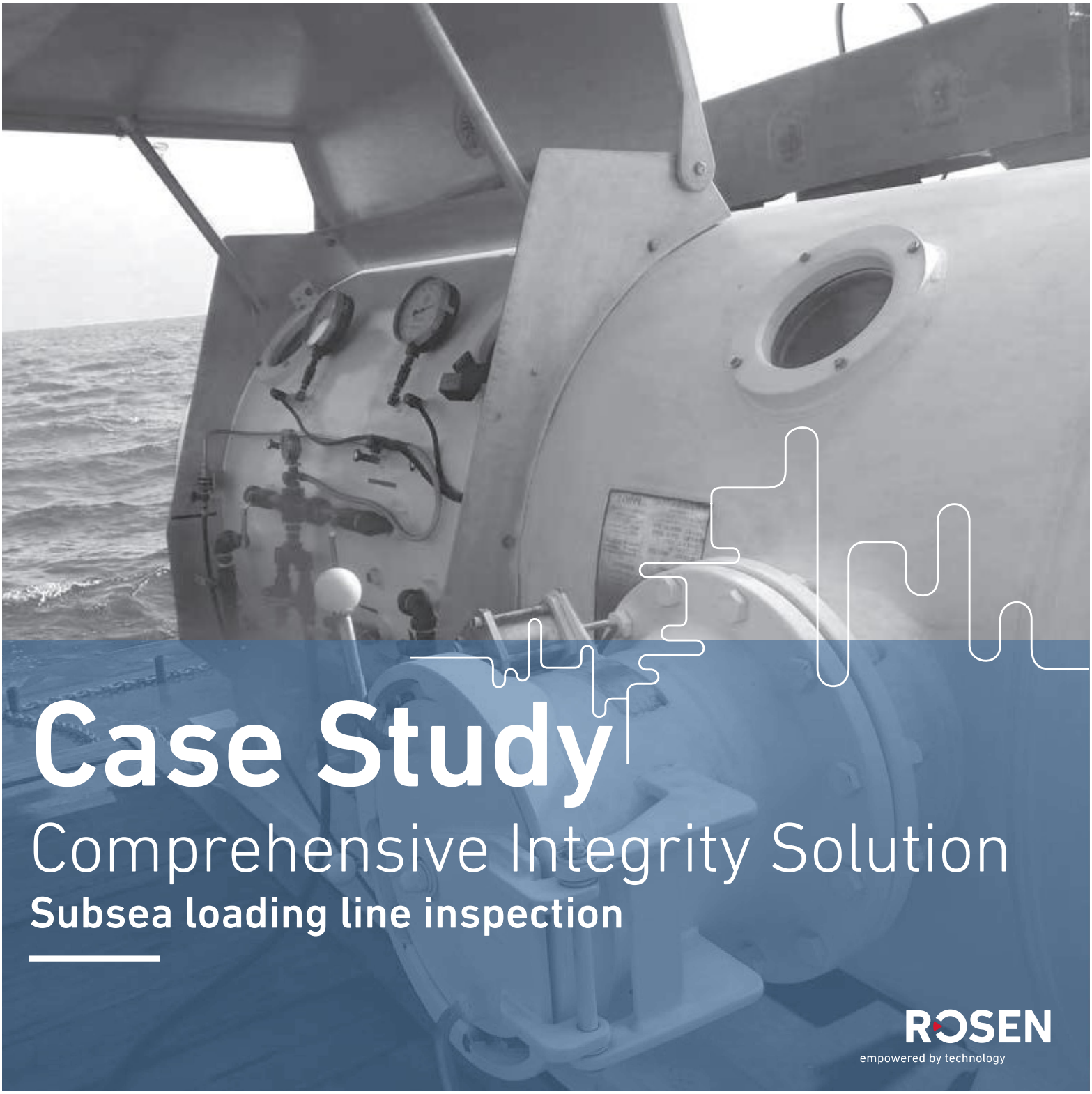

Case Study

Comprehensive Integrity Solution

Subsea loading line inspection

ROSEN
empowered by technology

The Challenge

ROSEN was contracted by a South American company to provide a solution to inspect two offshore loading pipelines, one 24" pipeline with a length of 16.7 km and the other 36" pipeline of 10.1 km. These systems connect onshore storage facilities to two subsea pipeline end manifold's (PLEM's), which are connected to a buoy by a flexible hose for the critical task of loading tankers. Due to its position in the pipeline system, this asset was deemed critical since there was no alternative means to import or export the product. The loading line in this case, by design, could not be inspected with a conventional inspection approach due to the following challenges:

- Single access
- No traps - subsea line ends at PLEM
- Unknown cleanliness
- Single flow direction

Additionally, the customer's comprehensive integrity system does not allow for reduced quality in their inspection datasets. As such, it was requested that ROSEN provide a high-resolution solution with optimal defect detection and identification for both internal and external corrosion features. The data analysis scope also required a post-inspection Corrosion Growth Analysis to be provided by ROSEN's Integrity Services. The customer also requested subsea georeferencing of their loading line system.

Our Solution

Conventional inspection methods would not obtain the high-quality data requested by the customer. Therefore, a free-swimming, bidirectional MFL-equipped solution, with a reversed cleaning approach, was devised. The benefits of this approach are:

- MFL technology is robust and known to be least sensitive to debris.
- Reversed cleaning allows for debris to be collected onshore, thus minimizing expensive subsea operations.

In order to provide a suitable solution for georeferencing the pipelines, ROSEN performed an in-depth market assessment on available technologies. The approach identified to be the most suitable for this application was a combination of technologies, including:

- A Differential Global Positioning System (DGPS) base station within the terminal and a mobile DGPS station on the vessel.
- An Ultra-Short Baseline (USBL) system on the vessel, from which the underwater positioning measurements are conducted.

In addition, at all pre-determined subsea reference points, the salinity, conductivity, temperature and pressure depth profile of the water was obtained to establish the speed of sound value.

Your Benefit

Despite the challenging offshore conditions, a very demanding scope, and the fact that this was the first utilization of the georeferencing technology, ROSEN was able to complete all onsite activities within the requested time frame. Furthermore, seven inline inspection surveys were completed onsite without any accidents or incidents and to the full satisfaction of the customer. The operator obtained valuable information on the integrity status of the asset, including the identification and localization of subsea defects and accurate strain analysis as a result of pipeline movement. This has allowed the customer to continue safe operation of the loading line system.

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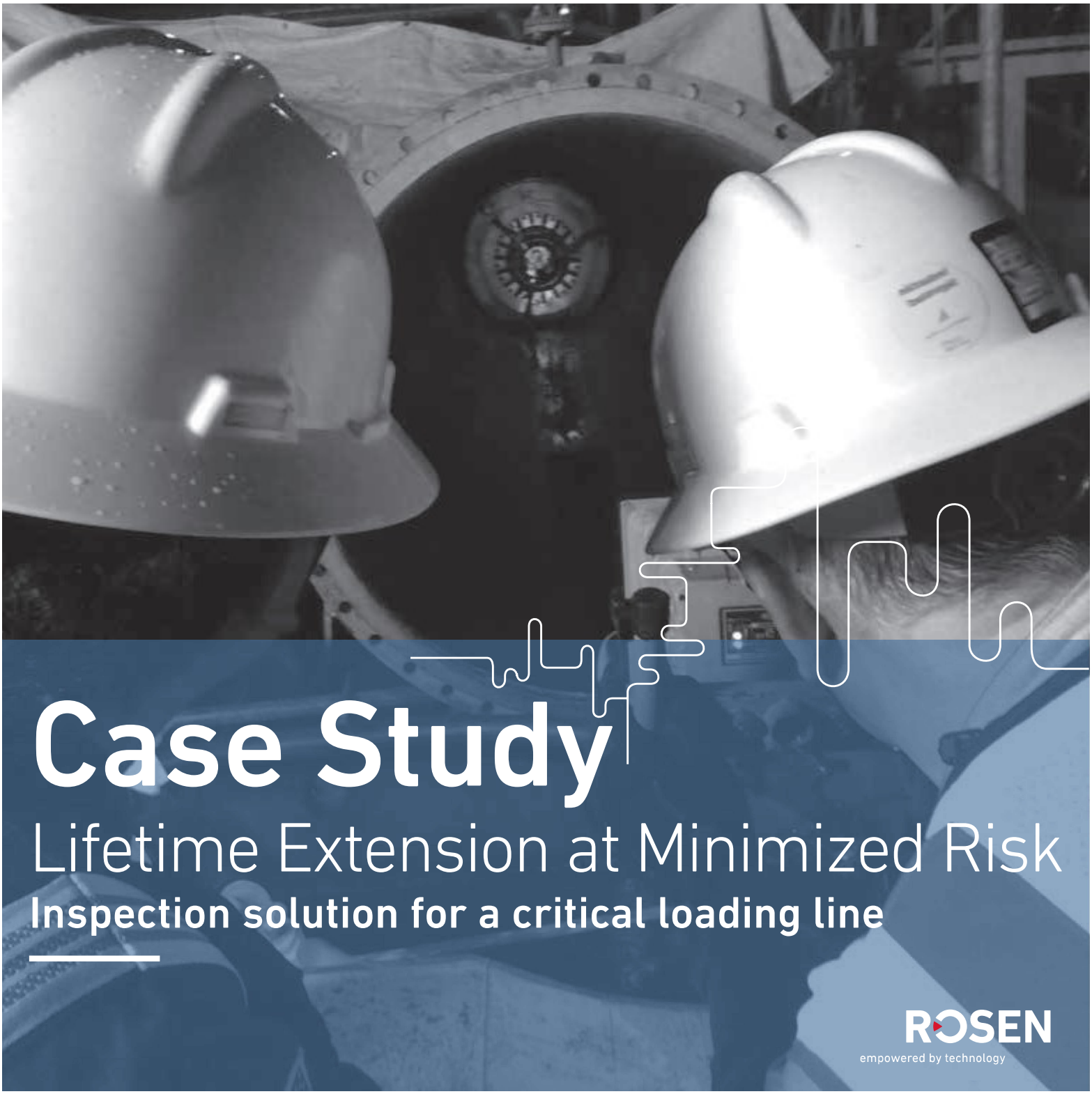

Case Study

Lifetime Extension at Minimized Risk

Inspection solution for a critical loading line

ROSEN

empowered by technology

The Challenge

In Asia Pacific, a 40" loading line connecting to a subsea PLEM for transporting crude oil from a local tank farm to sea-going vessels was in need of inspection. The client had initiated a modification of the existing PLEM which would require that part of the pipeline be raised and placed on a structure above the water line. This places significant strain on the pipeline which could further damage existing features. To ensure that this modification could be carried out safely, more knowledge concerning the integrity status of the line was essential. This project presented challenges associated with accessibility, negotiability, and propulsion, specifically:

- Single access to the line from the tank farm area
- The tool must be propelled in both directions
- The tool must stop five meters before the wye piece connected to the PLEM

Our Solution

In order to combat the various challenges presented in this case, the ROSEN team utilized the various elements from the Toolbox to customize the optimal solution package for the customer, including:

- Bidirectional low-friction 40" MFL unit
- High-resolution MFL technology
- 1.5D back-to-back bend passage capabilities
- Pumps controlling a propulsion medium of treated salt water
- Electronic Tool Detector III (EPD III) read-out consoles
- EPD subsea antennas placed on the pipeline for permanent and undisrupted communication

Subsea antennas detected the MFL unit as it traveled through the pipeline and approached the PLEM. The salt water pumps, through which the speed of the unit was controlled, successfully stopped the tool within 5m of the wye piece. The flow was then reversed and the inspection tool was pushed back to the launcher/receiver station. MFL technology was chosen because it provides ideal measuring performance and it is less susceptible to debris in the pipeline.

In spite of unforeseen environmental influences, such as multiple typhoons, the project was completed as scheduled. The collected data ensured a detailed integrity assessment of the entire pipeline. In fact, multiple anomalies were observed within the critical 500-meter zone before the PLEM. With this detailed information, the client was able to make informed decisions to avoid any incidents.

Your Benefit

Minimized Risk Exposure This solution, offering 100% coverage in one pass, not only saves operational cost, but also offers the highest probability of anomaly detection, allowing the operator to engage in an asset integrity management program.

Increased Uptime Inspecting loading lines must occur in a timely and efficient manner due to their vital positioning within distribution networks. The solution in this case offers a quick turnaround time as well as a robust and proven technology.

Lifetime Extension The current market situation calls for an even sharper focus on the care of existing and aging assets in the oil and gas industry. In the case of this particular loading line, the main reason for conducting this inspection was to provide required information to ensure the safe rehabilitation of a vital component.

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