STEALTH LOCK®

AGODCO ...more than energy

...the fastest line-pipe connection in the world

AGODCO

AGODCO Group of companies

Stealth-Lock™ value connection proposition reduces Cash Conversion Cycles for O&G operator & contractor pipeline projects.

The Mechanical Interference Fit "MIF Connection"

Stealth-Lock™ Mechanical Interference Fit (MIF) connection is our joining technology that provides faster, lower cost and safer methods to join carbon steel line pipes. In some circumstances mechanical connectors or couplings provide a lower cost and/or enabling advantage compared to welded connections for steel pipelines. Stealth-Lock™ is not a separate component connector, it's an interference joint cold-forming technology.

This interference results in the "Pin" being placed in compression by the additional expansion of the "Bell" during insertion. It is this compressive load applied across the joint engagement area in the presence of steel-on-steel friction that gives the connection its strength. The pipe properties define the system performance in each specification of; diameter, wall thickness, engagement length, coefficient of friction, and material grade.

Stealth-Lock™ is a cold-forming system that processes standard API pipes from Grade B to X70; SMLS, HFI or ERW. The pipes can be processed from client "free-issue" inventory or alternatively supplied via our vertically integrated value-chain consortium of partners.

In nominal diameters ranging from 2-inches to 16-inches (60-406mm), the system joins carbon steel bare pipe, FBE or 3LP coated, with wall thicknesses up to 1-inch (25.4mm).

	Quick Connection Data
Diameter (NPS):	2 to 16-inch (60-406mm)
Wall Thickness:	< 1.00” (25.4mm)
Material:	API Grade B to X70; SMLS, HFI or ERW
Service:	sweet & sour crude, gas, condensate, water, steam
Pressure:	as per line pipe material specification
Corrosion Barriers:	ID or OD FBE / Phenolic, 3LP < 2% H_2S, CO_2, Acids, SRBs

Steel pipelines - rapid “Press & Go” technology

Stealth-Lock™ MIF connections are engineered for service in both sweet or critical sour service, crude oil, gas, condensate, water or steam applications. There are many value-gain benefits for application of Stealth-Lock™. The speed of installation (with less manpower) is impressive but the performance gains compound as you consider some of the benefits that are shared across the project stakeholders: Before every completed pipeline is hooked up to service it is hydrotested and Stealth-Lock™ is no different. Although however, Stealth-Lock™ negates other non-destructive testing associated with welding such as ultrasonic or x-ray testing after connection as Stealth-Lock™ MIF is validated as a repeatable mechanical process.

Additionally, since the Stealth-Lock™ connection is a cold jointing process, there is no Heat Affected Zone (HAZ). This fact is added value for internal and external coating applications (no expensive internal FBE steel sleeves required). By combining different types of coating barriers with the Stealth-Lock™ connection, there is a reduction in all types of corrosion and abrasion of the pipe both internally and externally.

Typical barriers include but are not limited to ID or OD FBE / Phenolic, liquid and 3LP affording corrosive and abrasive protection against typical attack from H_2S, CO_2, Acids and SRBs. The hydraulic efficiency of the pipe is also increased significantly (25-35%). This leads to further value-engineering decisions where corrosion inhibitors can be eliminated and the pipe wall thickness can be reduced, often halving the cost of steel tube materials on the final project bill of quantities.

Forming the pipe-ends with Prepping Facilities on the move

Firstly, the source pipe is “prepped” and this function can take place, at the pipe mill, the coating applicator or even in the pipe yard at the project location. Jointing will take place later after firstly cold-forming the two mating parts of the carbon steel pipe into a “Bell” at one end and a “Pin” at the other. The Bell is formed by a mandrel that elongates the pipe end and the Pin is formed by a swage that compresses the other end into a taper form.

During belling, the internal diameter of the Bell is expanded and the increase effected by the mandrel is engineered so that the Bell ID will be relationally smaller than the Pin OD thereby controlling the degree of interference after the ends are joined. This interference ensures that the Pin is placed in a state of compression by the additional expansion of the Bell during insertion. Prepping productivity can achieve up to 600 pipes per day and our prepping facilities can be fixed units or in some cases, capable of mobilizing and set up within three working days plus airfreight time for international project locations.

accelerated completion & cash conversion cycles
up to 2km constructed per day, per crew
less than 10% of manpower required
more than 10x faster than welding
no hot-works for Stealth-Lock™
no hazardous radiography
no internal sleeves

Connecting with Global Value Chain Partners and extending the reach of the Stealth-Lock™ MIF Connection.

Vertically Integrated Global Chain Partners or Client free-issue pipes?

Both. Stealth-Lock™ Mechanical Interference Fit (MIF) connection can be considered both as a connection system service and in certain cases, together with our Global Value-Chain partners, it can be supplied as a vertically integrated product that includes materials, logistics and the final "Supply-Connect" service.

In most pipeline construction projects, client hydrocarbon operators are more likely to supply Stealth-Lock™ with what is referred to as "free-issue pipes". In that scenario, we interface with the client and its awarded contractor in order to provide the prepping services (prior to coating). We then follow through with joining activities as per the scope.

Unlike our competitors we are not owned by a coating applicator company. Stealth-Lock™ is a wholly owned subsidiary of the AGODCO Group and enjoys independence and the ability to commit to clients the ability to mobilise to any client approved coating applicator or indeed source pipe mill. This freedom affords greater choice to our clients when selecting particular coating product and service vendors worldwide.

Tests	Typical Test Data #1 Average Results & Specification Compliance
Axial Tension:	>90% UTS : ASME B31.4 / B31.8, ISO 21329 (app. Level 4)
Axial Compression:	>95% UTS : ASME B31.4 / B31.8, ISO 21329 (app. Level 4)
Internal Pressure:	>95% UTS : ASME B31.4 / B31.8, ISO 21329 (app. Level 4)
Bending:	>95% UTS : ASME B31.4 / B31.8, ISO 21329 (app. Level 4)

Global reach with Stealth-Lock™ MIF Connections

Over the years, Stealth-Lock™ has driven parallel R&D and commercial initiatives with truly global players such as steel tube manufacturers and coating applicator companies. Now, through what we call our "Global Value Chain" it is possible to provide clients with a vertically integrated product and service. In simplicity, we can supply the pipe, the coatings, the logistics and all the way through to the hook-up of the Stealth-Lock™ pipelines and, we do this using invoice triggers that don't activate until the materials land at the wellhead or project location with the final invoice upon hydrotest and handover.

The Cash Conversion Cycles are fractionalised for all stakeholders involved. The client starts receiving its hydrocarbon production within a couple of weeks of receiving his first materials invoice. The contractor minimises his operational expenditure and collects his cashflow faster. Redundancy, damages, delays, hazards and risks are all diminished to negligible levels compared to conventional welding supply-chain and operations.

Contact us today to enquire more about our "Supply-Connect" service and to discover our global reach via our Global Value Chain network that includes some of the largest and best trusted vendors in the hydrocarbon materials and services sectors.

Mobilizing prepping facilities to the mill, coating plant or, in the field

The versatility and portability of the Stealth-Lock™ MIF equipment means all self-sufficient prepping and field assembly machinery, packs into one specially modified 40' sea container that can be mobilized by land or sea to just about any location in the world. For acceleration of existing projects, we utilize air-cargo as a fast mobilization solution to getting the job done in a reliable, safe and compliant way.

Stealth-Lock™ MIF productivity with its inherent reduced operating costs cannot be matched by traditional methods of welding (or even by other types of mechanical connections) on carbon steel line pipe. The numbers are outstanding and speak for themselves. For example, one spread of Stealth-Lock™ plus crew can perform anything up to 2 kilometres of constructed pipeline per day. Depending on pipe diameter and topography, that's the equivalent of 10-15 welding crews on a joint-for-joint comparison.

This productivity is also complimented by the fact that installation of Stealth-Lock™ is not considered as "hot-works" so the associated hazards and risks are greatly reduced and this is essential when working near to live lines and/or gathering stations. The benefits derived from Stealth-Lock™ are numerous both in financial and safety metrics.

works with standard API 5L client free-issue pipes, or;
vertically integrated, value supply chain is available
prepping pipe at the mill, coating plant, or the field
diameters range from NPS 2-inch to16-inch pipes
Wall Thickness up to 1-inch (25.4mm)
works with bare pipe or coated ID and/or OD

Investing and engaging with local communities whilst transferring knowledge, expertise and safety disciplines. It all begins in the classroom.

Corporate Social Responsibility starts by recruiting and training locally

Corporate Social Responsibility (CSR) is at the core of our worldwide operations and that's why Stealth-Lock™ integrates social and environmental concerns into its business operations and that governs all of our interactions with stakeholders on a voluntary basis. Stealth-Lock™ is committed to adopting best practice in this domain.

Stealth-Lock™ people are committed to navigating our businesses through a forward-thinking position of sustainability as a key lever to long-term success and ultimately, high performance. We leverage our assets and capabilities to drive innovation and growth while striving for a positive economic, environmental and social impact. We invest in the ethos of "Localisation" insofar that we will actively encourage recruitment and career development for indigenous citizens of those countries where we operate. We tenaciously drive for year-on-year percentage growth. Localisation is always a mantle on which we build long-term futures, not just because we have to, but because it makes good practical, social and economic sense. The outcome plays its role in a bright and sustainable future for the people, the local communities and our worldwide businesses alike.



	Typical Test Data #2
Tests	Average Results & Specification Compliance
Fatigue – in air:	DnV D Class weld curve : BS 7608 F2 / DNV C1, ISO 21329 (app. Level 4)
Fatigue – in water:	DnV C2 Class weld curve : BS 7608 F2 / DNV C1, ISO 21329 (app. Level 4)
Electrical Resistivity:	±1μΩ / connection : N.B. 10A, 25mV FSD
Stress Corrosion Cracking:	No reduction in strength : NACE MR0175 / NACE TM0177 - Method A
Crevice Corrosion:	No reduction in strength : 30days exposure > 130°F 500psi; 1,000ppm CH_3COOH 30% CO_2, 70%N_2

From the Classroom to the Field

Safety and Quality (in that order) are at the core of everything we teach from the classroom to the field of operations. For our candidate teams to be totally safe, proficient, and self sufficient in their pipeline projects, we build expertise from the classroom up. All of our Stealth-Lock™ candidates are put through a rigorous academic and practical training program to NVQ Level 2 Diploma certification equivalency that teaches them the importance of "HEMP" (Hazard & Environmental Management Planning) together with an array of technical and practical know-how that leads them into higher vocational achievement and wider safety training and accreditations.

Stealth-Lock™ certified technicians perform pipeline construction works on a daily basis in some of the most extreme environments that can range from jungles and deserts to icy terrain and mountains. Facing up to the inevitable challenges of keeping safe operations moving in the field, our honed and disciplined leaders have the skill sets required to accomplish project missions with competence and compliance to all required standards.

AGODCO "Route to Competency" syllabus – MIF Connection Training

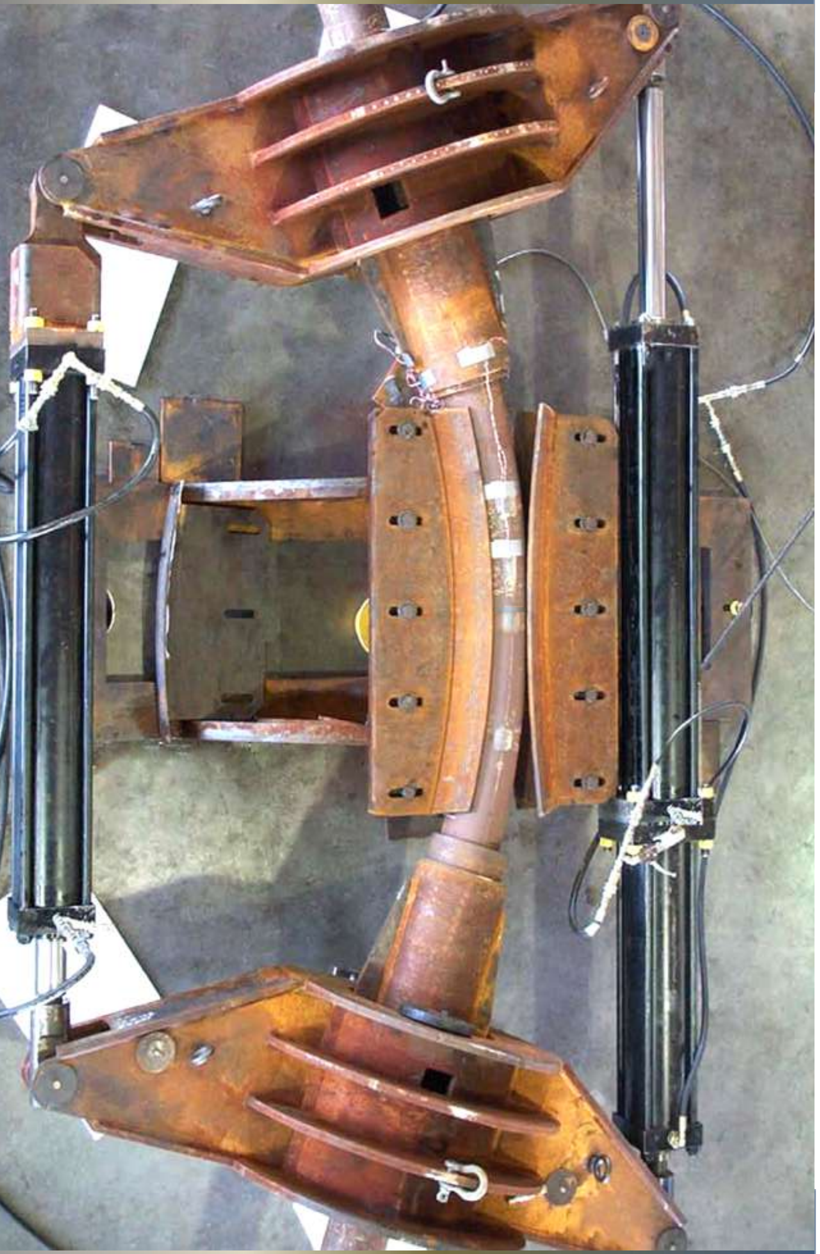
AGODCO, is the OEM of the Stealth-Lock™ Mechanical Interference Fit pipe connection technology and it introduced its method of training and validating skills in the specialist MIF connection jointing discipline in 2011. It was then formalized as *"MIF-Skills"* with AGODCO approved training modules and courses that derived from the connection technology Stealth-Lock™ MIF joint Integrity technical training standards.

Since then, training modules have been developed and enhanced, and work based task assignments and new AGODCO qualifications were introduced in 2017. The new technical training standards cover equipment orientation, mechanical maintenance, prepping and joining pipe and understanding safe operation of the hydraulic power units engaged in the processes. Related independent safety training, evaluation, testing and accreditation is provided by specific third-party institutions and knowledge partners.

Different People – Same Values

Our People stem from a diverse range of nationalities, religious beliefs and cultural backgrounds. This is what makes us all to be a wealth of human capacity for tolerance and mutual respect in more ways than one. From the four corners of the globe, our People come together, united in their approach to their personal and professional development. At Stealth-Lock™ we may be very different people, but our common defining factor is that we are proud to part of a family that shares the same values.

knowledge training for indigenous citizens, on all operations
equal opportunities for all nationalities, races and genders
AGODCO MIF training courses (training center based)
work based task assignments (in the project field)
technical tests & operator qualification (test center based)
awareness training for H_2S plus Gas Mask safety qualification
training and qualification for Initial Fire Response (IFR)
specialized: Defibrillators in Remote Environments (DRE) Certificate

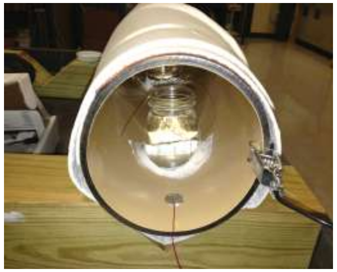


Independent laboratory research, testing and validation for over thirty years. Proven strength and lasting integrity for Stealth-Lock™ pipelines.

Innovating and validating with the best independent laboratories

High confidence and pipeline integrity is at the vanguard of our Stealth-Lock™ MIF system. In order to uphold and to continually improve upon our performance, we rely upon a handful of world renowned and truly independent research and testing laboratories such as Stress Engineering Services based in Houston, Texas. A well renowned leader in mechanical testing of force, load, tension, pressure, fatigue and temperature. Our R&D engineers have worked alongside Stress Engineering in a combined effort to maximise and validate the performance envelopes of the Stealth-Lock™ technology. Clients can be sure in the knowledge that Stress Engineering test results are completely independent, objective, and trusted by all major oil and gas client operators on a worldwide basis.

In addition to Stress Engineering, we also rely upon a wide range of specialist expertise that sits with Southwest Research Institute (SwRI), headquartered in San Antonio, Texas. We also credit our Global Value Chain partners including a world-leading pipe and tubular product manufacturer who has independently verified Stealth-Lock™ for its application across Latin America to hydrocarbon operators from Argentina to Mexico.



Tests	Typical Test Data #1 Average Results & Specification Compliance
Axial Tension:	>90% UTS : ASME B31.4 / B31.8, ISO 21329 (app. Level 4)
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Bending:	>95% UTS : ASME B31.4 / B31.8, ISO 21329 (app. Level 4)

Performance history across typical Stealth-Lock™ test results

The abundance of results generated from years of continual testing, both third-party and field hydrotesting evidence that the performance of the Stealth-Lock™ connection is at least equal to, if not better than that of each specification of the pipe body base material tested. Test results compliant to related specifications and standards indicate that the Stealth-Lock™ connection almost always yields on destructive tests at stresses in excess of the specified minimum yield strength of the parent pipe material. We layout below highlighted significant tests that are intrinsic to our R&D and validation programs:

Axial Tension Capacity: The axial tension capacity of the Stealth-Lock™ MIF connection increases with pressure and the insertion depth. The axial tension capacity is above 90% of the ultimate tensile strength of the parent pipe. However, this metric can be improved by increasing the specific insertion depth and also by being in service at high pressure as this assists the axial tension that is the friction between Bell and Pin (to a certain point).

Pressure Rating: The pressure capacity of the Stealth-Lock™ connection is the same as the parent pipe since it has been proven to be an effective “positive seal.”

Bending Capacity: Depending on the pipe diameter and the wall thickness, bending of the Stealth-Lock™ connection performs well under the conditions imposed on mechanical installation tests (ISO 21329) although bending induced stresses will tend to differ greatly depending on diameter, grade and wall thickness.

Compression Capacity: The compressive capacity of the Stealth-Lock™ connection is the same as the parent pipe since it is effectively a positive seal.

Fatigue Capacity: The connection can confidently be considered as a C2 class weld.

Conclusive confidence in Stealth-Lock™ Connections

Numerous Stealth-Lock™ assessment and test programs have been completed with positive results that crystalize conclusive confidence that Stealth-Lock™ MIF connections are technically feasible for application in both offshore and onshore service conditions. Stealth-Lock™ connection qualification programs are generally based on either of two standards; ISO 21329 or ISO 13679. Both the empirical and numerically modelled data is clear validated evidence that the Stealth-Lock™ mechanical interference connection system is technically acceptable to be applied for hydrocarbon or water injection pipelines in compliance with the industrial codes and standards. All tests are based on API 5L pipes from Grade B to X70; SMLS, HFI or ERW. Applied nominal diameters ranging from NPS 2-inches to 16-inches (60-406mm) with wall thicknesses up to 1-inch (25.4mm).

Installation Tests ISO 21329
Operational Restrained & Unrestrained Tests ISO 21329
Hydrostatic Pressure Tests ISO 21329
Limit Load Tests ISO 21329
Fatigue Tests. BS7608 and DNV C203
Pressure, Axial Load, Bending ISO 13679:2002(E)
Electrochemical Impedance Spectroscopy Test (EIS)
Tensile, Charpy & Hardness Tests API 5L and ISO 3183
Sulphide Stress Cracking (SSC) NACE TM0177

Innovation leads to continuous testing and validation. Proving strength and integrity for Stealth-Lock™ MIF.

Sulphide Stress Cracking (SSC) NACE TM0177

SSC occurs in sour service applications and under the combined action of tensile stress and corrosion in aqueous environments containing hydrogen sulphide (H_2S). All SSC tests are carried out using C-ring method as shown in the diagram below. Both the external and internal surface of the MIF Stealth-Lock™ specimens are stressed and the applied stress of 90% AYS determined via strain gauges affixed to the test coupons.

The test cycle for any specimen coupon exposure is for a 30-day period. The test solution 'A' with reagent grade oxygen-free nitrogen and 99.5% minimum purity hydrogen sulphide gas (H_2S) is used for the tests. The test water is distilled or de-ionised, conforming to ASTM D1193-Type IV.

Following the specified test period the specimens are visually inspected and then again utilizing both MPI and metallographic examination. On all inspections there was no suspect evidence of SSC cracking and no additional suspect indications associated with HIC where observed. This resulted in a successful test outcome.

Further to testing, its was concluded that Stealth-Lock™ MIF is conducive to application in critical sour service environments and does does not adversely affect the integrity of the pipeline especially when used in conjunction with FBE ID coatings.

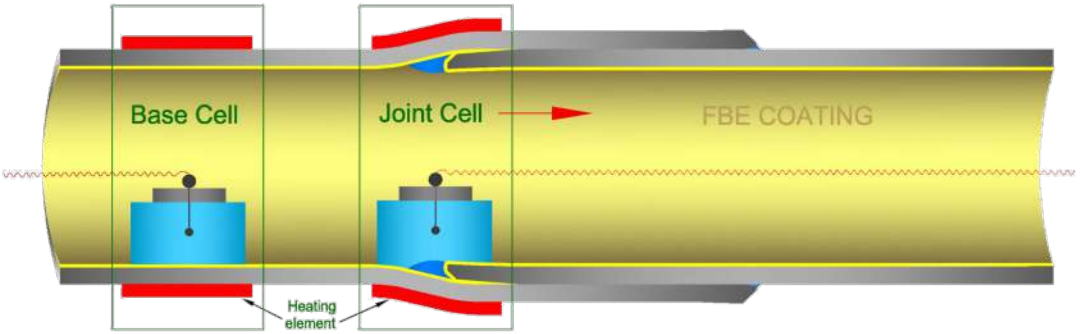
Electrochemical Impedance Spectroscopy (EIS)

The purpose of the EIS tests are to validate the claim that Stealth-Lock™ MIF does not affect the compliant integrity of the FBE ID pipe coating. Electrochemical Impedance Spectroscopy (EIS) has been proven to be a powerful quantitatively and also is a non-destructive technique in the understanding and characterization of protective coatings and how they interact with connections.

One of the more common EIS-derived parameters used to qualify the degree of corrosion protection provided by an organic coating has been the pore resistance (RPO), and the coating capacitance CC, corrosion resistance (RCORR), or a similar measure of the barrier property or corrosion rate of the coated substrate. And, as such the derived parameters where used to test the connections.

All of the EIS Tests performed on the Stealth-Lock™ MIF specimen joints had two electrochemical cells mounted on the ID of the specimen joints that had been previously coated with a widely approved Fusion Bonded Epoxy (FBE) coating. One cell placed in the base FBE coating (away from the joint) and another cell placed across the joint where the "Taper" meets the final insertion point into the Bell.

Each cell was filled with 25% NaCl solution. The steel surface was heated to 95°C for the duration of the test that was 28 days. Measurements of EIS were performed at 1 hour, 1 day, 1 week, 2 weeks, 3 weeks, and 4 weeks after exposure. Stealth-Lock™ MIF joints did not cause solution to penetrate and therefore the integrity of the FBE coated Stealth-Lock™ connections were confirmed as validated.



Installation, Operation; restrained, unrestrained & limit load ISO 21329

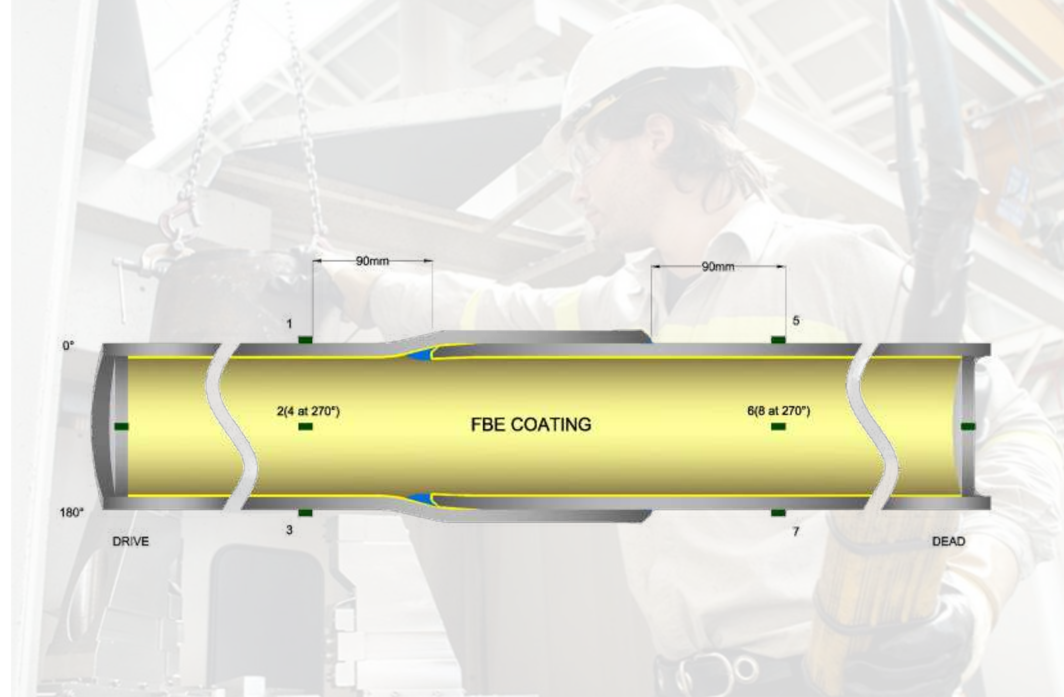
The Operational tests include pressure and bending loads and thermal cycling. The difference between the restrained and unrestrained Stealth-Lock™ tests is the axial force and moment applied during testing. No axial force is applied for the unrestrained tests, and no moment is applied for the restrained tests. During the operational tests, axial and bending loads are cycled between no load and the calculated load equivalent to operation loading and, temperature is then cycled between lower and upper test temperatures. A total of 20 cycles is accepted for the normal confidence level, and 100 for the high confidence level.

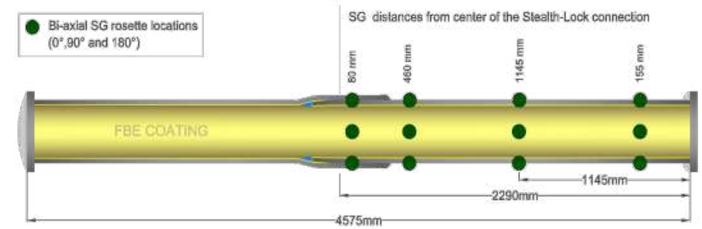
The Stealth-Lock™ specimens were strain gauged prior to testing in order to measure membrane (hoop and axial) and bending strains. Axial tension and four-point bending loads were applied to the samples to simulate maximum loads associated with the in-service conditions as predicted by analysis. Internal pressure was applied before and after loading to check for leaks in the connection. No leaks were detected in any of the Stealth-Lock™ MIF tests.

Resonant Bending Fatigue Testing BS7608 and DNV C203

Provides high-speed fatigue testing of full-scale pipe specimens to verify fatigue resistance of the Stealth-Lock™ MIF joints. The tests involved applying sinusoidal alternating bending fatigue stresses around the entire pipe circumference to stimulate the pipe specimen to near its resonant bending frequency. With the use of internal pressure in the test samples, a mean axial stress was also imposed.

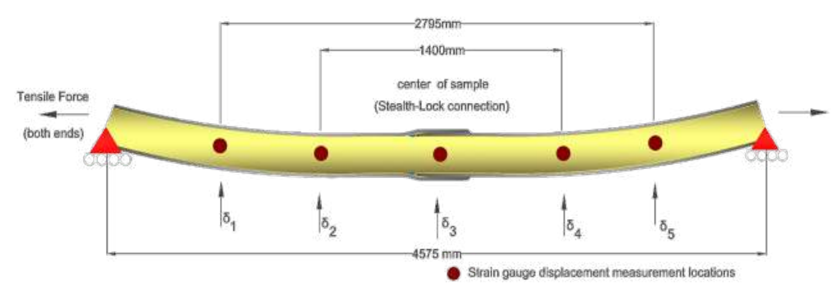
Generally, tested MIF samples diameters range from 2" to 16" with an average cyclic bending stress range of 5 to 50ksi (35 to 350 MPa). Cycle rates typically average about 2.5 million per day while alternating fatigue stresses are continuously monitored by a high-speed data-acquisition system. On the Stealth-Lock™ specimens no leak paths where detected and in all cases the girth welds on the blinding plates yielded and not the MIF joints. The results indicated that the girth welds are significantly less fatigue resistant than Stealth-Lock™ connections as the failures occurred on the girth weld and/ or the pipe body following a minimum 800,000 cycles at 208 MPa. This result is typical with many other fatigue tests conducted on the Stealth-Lock™ MIF connections.





Sample strain gauge location diagram

(Four-point bending force locations)



TEST CONDUCTED ON A 450 TON HORIZONTAL BENDING FRAME

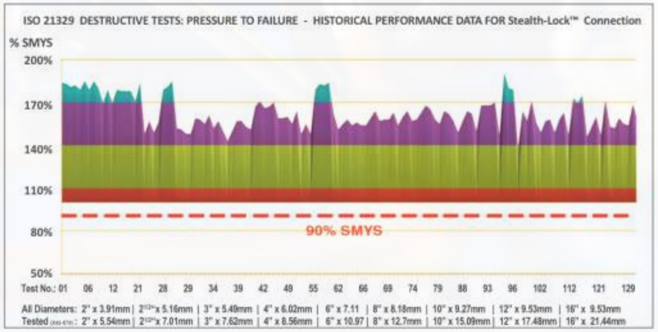
Harnessing the stresses and positive forces. Tenacious design analysis with continuous testing of strength and integrity for the Stealth-Lock™ connection.

Raising the Bar with Stealth-Lock™

For more than thirty years, 100% of pipelines with Stealth-Lock™ applied connections placed into service, have passed successful, non-destructive field hydrotests. Most of the standard hydrostatic tests are performed at client specified parameters that are typically set at 125%-150% of the designed service pressure (MAOP). In addition to the literally thousands of successful field pressure tests, Stealth-Lock™ connections have, over the years been regularly subjected to hundreds more laboratory condition mechanical tests, many of which are related to pressure.

In our tenacious mission to “raise the Bar”, the laboratory test results are impressive. Maximum peaks where the MIF yielded (typically the pipe yielded before the MIF joint) were recorded as high as 186% of SMYS (Specified Minimum Yield Strength). The lowest MIF yield was at 142% of SMYS. Pressure integrity performance of the Stealth-Lock™ connection is well above the industry test baseline standard of 90% SMYS.

Since the Stealth-Lock™ MIF is formed from the actual pipe itself, there is no separate material connection so Stealth-Lock™ is not “de-rated” as in the case of other MIF connections. The design of the pipeline remains a function of the pipe diameter, wall thickness and intended operating connection preparation and make-up pressures.

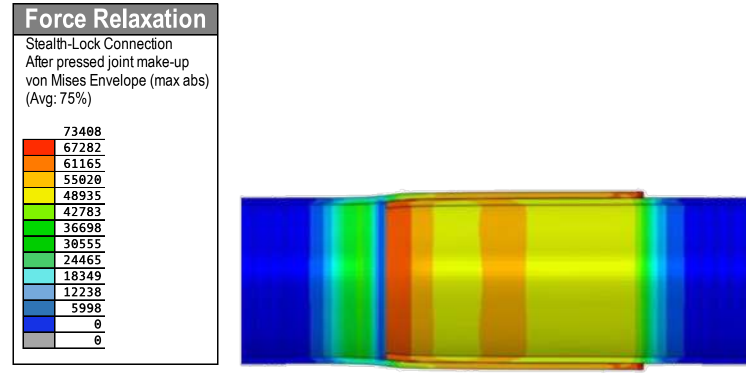


Axial Tension and Pressure are positive forces

For much of its strength performance, the Stealth-Lock™ connection harnesses both the elastic and plastic properties of contemporary steel alloys. This can be evidenced by the examining and testing of two forces. The Axial Tension and Internal Pressure to a point, work together to increase the strength performance of the Stealth-Lock™ connection.

When examining Axial Tension, following the extraction of the mandrel, there is an amount of stress / strain relaxation which results in a marginal reduction in the diameter of the Bell but in every case, a residual stress exists to provide connection integrity after insertion of the Pin takes place. During Pin insertion into the Bell, an immense amount of force is applied by the Stealth-Lock™ assembly machine because the Pin, that is API standard diameter has a slightly larger outside diameter than the engineered and cold-formed internal diameter of the Bell. This produces a radial friction pressure force between the Pin and the Bell which in turn compounds a positive contribution to the axial tension capacity of the Stealth-Lock™ connection after joining.

When examining pressure dynamics either in the laboratory or in service in the field, it is easy to come to the validated conclusion that to a point, when increased internal pressure is applied to the Stealth-Lock™ MIF connection, the Pin is marginally expanded resulting in the compressive strain relieving, thus increasing the radial contact force that places it under radial compression similar to that of external pressure. With the Bell internal pressure, these forces increase the axial tension capacity across the Stealth-Lock™ connection (until the ultimate failure point on destructive testing).



Comprehensive states of stress

As a validation step, on new sizes a finite element analysis (FEA) is compared to the experimental results during; joining and tension to failure experiments. The FEA modelling is able to analyse very precise and idealized conditions, but however there are some physical aspects which cannot be determined by the FEA. As a result, physical tests are generally performed on new size Stealth-Lock™ connections in accordance with ISO 21329 to complete full validation. Full-scale testing generally follows the standards ISO 21329 or ISO 13679:2002E, both evaluate comprehensive states of stress. This type of testing consists of static strength combined loads, including bending, tension or compression, and internal pressure. After static strength load paths are executed, ultimate capacity of the specific Stealth-Lock™ connection being evaluated in tension, pressure, combined tension, pressure and bending.

Connection Preparation and Make-Up

The connection make-up process consists of belling activities and pin insertion. The FEA model is used to simulate the belling process involving mandrel insertion and mandrel removal and then final Pin insertion to the Bell. During the mandrel insertion, the pipe end is plastically strained. Following the extraction of the mandrel, there is an element of stress / strain relaxation which results in the marginal reduction of the Bell diameter in that particular area, however a residual stress exists to provide connection integrity that will be experienced upon make-up of the Stealth-Lock™ connection.

During Pin insertion into the Bell, a considerable amount of force is applied in order to drive the Pin, which has a slightly greater outside diameter than the Bell inside diameter. This produces a radial pressure between the Pin and Bell which provides positive compounded force to the axial tension capacity of the Stealth-Lock™ connection. After the connection is made up, it can be evidenced that the Pin is under radial compression similar to external pressure and the Bell is under internal pressure. As evidenced in the adjacent images, the stresses in the Pin decrease toward the end of the Bell. During production service when the internal pressure is applied to the Stealth-Lock™ connection, the Pin is further expanded resulting in the compressive strain relieving and hence increasing the radial contact force.

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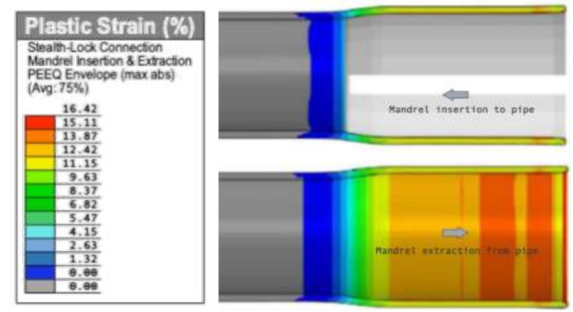
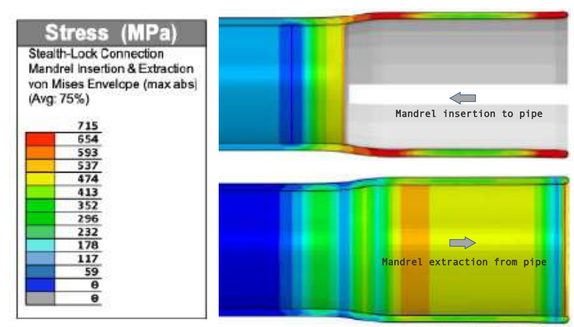
Typical Test Data #2

Tests	Average Results & Specification Compliance
Fatigue – in air:	DnV D Class weld curve : BS 7608 F2 / DNV C1, ISO 21329 (app. Level 4)
Fatigue – in water:	DnV C2 Class weld curve : BS 7608 F2 / DNV C1, ISO 21329 (app. Level 4)
Electrical Resistivity:	±1μΩ / connection : N.B. 10A, 25mV FSD
Stress Corrosion Cracking:	No reduction in strength : NACE MR0175 / NACE TM0177 - Method A
Crevice Corrosion:	No reduction in strength : 30days exposure > 130°F 500psi; 1,000ppm CH_3COOH 30% CO_2, 70%N_2



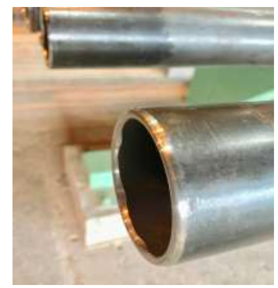


Interfacing with the best corrosion barriers. Internal and external integrity protection that works hand-in-glove with the Stealth-Lock™ connection.

Open global market on all coating applicators

Stealth-Lock™ is differentiated from our global competitor, as it is not owned or exclusively ventured with any coating applicator or coating product manufacturer. This fact is important to our global client operator base. The result is our complete flexibility, being able to mobilize equipment and technical manpower to virtually any of the client specified applicators, worldwide. Why is this important?

Many operators are turning to corrosion barriers such as internal FBE as production service is transitioning from sweet to critical sour service environments. The benefits of enhanced oil recovery are many but however, the use of steam, water injection and other techniques results in biological change that leads to high sulphur conditions, H_2S and sulphide stress cracking of carbon steel materials. The Stealth-Lock™ connection system works hand-in-glove with just about any internal and external coating barrier and at Stealth-Lock™ we will work with all client approved applicators and products.



Holiday-free joints. No repairs needed. No ID sleeves.

There are many integrity enhancing and commercial benefits to applying Stealth-Lock™ in conjunction with corrosion barrier coatings. Firstly, FBE coated pipes that are welded require a third component which is a fabricated and coated steel protective sleeve that is inserted to the connecting pipes ends as a protective barrier in the Heat Affected Zone (HAZ). It is designed to prevent burn damage to the FBE coating during welding. With Stealth-Lock™ there is no sleeve requirement, no time consuming welding and no x-ray of the joint. Just a few seconds of pressing the friction-fit interference connection.

The specially designed Stealth-Lock™ interlocking overlap results in a verified holiday free connection every time. No exposed bare metal, resulting in critical sour service corrosion free pipelines in service for up to twenty years (and sometimes beyond).

Corrosion and abrasion external coating. It's a simple interface.

The same interlocking design works for the external side of the Stealth-Lock™ joint. As with the internal coating design, the OD "cut-back" of the external coating from the Pin ensures metal-to-metal friction produces the desired radial and axial tension capacity of the Stealth-Lock™ designed connection. The common external corrosion and abrasion barriers applied with Stealth-Lock™ include, 3LP, FBE and or Phenolic liquid coatings.

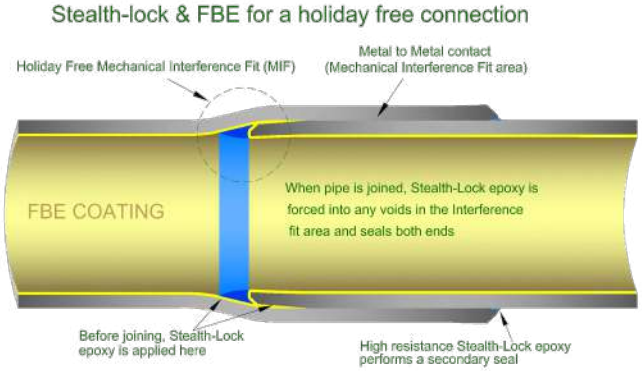
With all coating project interface requirements anywhere in the world, Stealth-Lock™ will assess the technical and commercial requirements, working with the client specified applicators. Technical knowledge-transfer and assistance is professionally given to the particular applicator so that Stealth-Lock™ specific coating protocols are applied.

Reducing material costs and innovative Stealth-Lock™ fittings.

The common engineering shortcut to fighting sour service is to simply increase the wall thickness of the carbon steel pipes and fittings being installed. Perhaps, this ultimately pushes back the problem to medium-term but the true long-term solution is to reduce the wall thickness (say Sch.80 to Sch.40), and apply internal coating together with the Stealth-Lock™ connection system. This will quite literally half the material costs and in critical sour service, more than quadruple the service lifetime of the pipeline itself.

To further reduce the need for welded connections to; tees, bends and flanges and other types of standard fittings, Stealth-Lock™ often pre-fabricates short sections of Bell and Pin pipes that are welded and pre-coated for use on specific projects. This is especially useful when construction of the straight-line is approaching a direction change, road crossing or any other type of requirement to tie-in the pipeline.

in sour service, reduce steel material cost by up to 50%
increase pipeline service lifetime circa 400% in critical sour service
no internal HAZ protective sleeves required
ID or OD FBE / Phenolic, 3LP < 2% H_2S, CO_2, Acids, SRBs
pipe ends are specially designed for metal-to-metal interlock, FBE overlap



From CS to FBE
Stealth-Lock™ delivers Integrity

VIDEO

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STEALTH LOCK®
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Extreme data acquisition exclusive
to Stealth-Lock™ connection technology

STEALTH BLU BOX™