CAPABILITY STATEMENT

Cathodic Protection Services

Field Gradient Sensor (FiGS) & CP Modelling (SeaCorr™)

FORCE Technology Norway

2017

Cathodic protection services and solutions

In order to prevent corrosion from damaging and tearing down valuable assets, cathodic protection systems are normally installed at subsea structures and pipelines. We have more than 35 years of experience within cathodic protection and offer various types of solutions.

We provide a wide range of cathodic protection (CP) services and solutions that prevent and control corrosion, including:

- CP design
- CP modelling
- CP inspection
- CP management and consulting

By combining practical and theoretical approaches we are able to provide more accurate results about assets condition. This is a valuable information to optimise inspection intervals and to perform life extension studies.

We deliver CP services from the design phase to the end of the asset lifecycle.

Field Gradient Sensor (FiGS®) and CP Modelling (SeaCorr™)

Introduction to FiGS

FORCE Technology Field Gradient Sensor (FiGS®) is a state of the art non-contact CP inspection tool, that performs highly accurate measurements of electric currents in seawater, with a resolution and detection level that surpasses all other field gradient sensors available on the market. The sensitivity of the sensor enables the identification of corrosion problems and the characterization of CP system status on pipelines and subsea structures, even when buried. The figures below show a comparison between traditional CP techniques and FiGS for both exposed and buried pipelines & structures. It also shows the available data for each technique and the limitations.

EXPOSED STRUCTURES AND PIPELINES	Stabber/ Proximity/ Drop Cell	Cell to Cell	Dual Cell (Field Gradient)	FiGS (Field Gradient) FiGS
Potential profile	Possible	Possible	Not Possible	Possible
Anode current	Not Possible	Not Possible	Possible	Possible
Anode wastage	Not Possible	Not Possible	Possible	Possible
Coating damages	Not Possible	Limitations	Limitations	Possible
Steel current density	Not Possible	Not Possible	Limitations	Possible
Current drain to e.g. piles, wells & substructures	Not Possible	Not Possible	Limitations	Possible
Outer sheat damage on flexible pipes	Not Possible	Not Possible	Not Possible	Possible
Correction of pipe routing	Not Possible	Not Possible	Not Possible	Possible

/ Figure 1 – CP techniques and limitations for exposed structures and pipelines.

BURIED STRUCTURES AND PIPELINES	Stabber/ Proximity/ Drop Cell	Cell to Cell	Dual Cell (Field Gradient)	FiGS (Field Gradient) FiGS
Potential profile	Not Possible	Limitations	Not Possible	Possible
Anode current	Not Possible	Not Possible	Limitations	Possible
Anode wastage	Not Possible	Not Possible	Limitations	Possible
Coating damages	Not Possible	Not Possible	Not Possible	Possible
Steel current density	Not Possible	Not Possible	Not Possible	Possible
Current drain to e.g. piles, wells & substructures	Not Possible	Not Possible	Not Possible	Possible
Outer sheat damage on flexible pipes	Not Possible	Not Possible	Not Possible	Possible
Correction of pipe routing	Not Possible	Not Possible	Not Possible	Possible

/ Figure 2 – CP techniques and limitations for buried structures and pipelines

Accurate field gradient data from FiGS combined with FORCE Technology's proprietary CP Computer modelling expertise will not only give our clients confirmation of a protected structure. Compared to traditional CP inspection techniques, life expectancy of the system will be calculated more accurate and the following extras will be detected, interaction between connected systems, drain to buried structures and real steel current densities. The steel current density will tell you how much current and anode mass is required to protect a given structure. Design codes are also usually overly conservative when specifying the steel current density, and using real values in retrofit CP designs have demonstrated typical cost savings of 50%

What can FiGS do?

FiGS is a non-contact CP inspection tool, and the only tool on the market of its kind that:

- Detects coating damages on exposed and buried pipelines and structures - sizes of defects will also be calculated
- Accurately measures anode performance (output) – for evaluation of anode wastage and remaining service life
- Determines steel current densities - remaining service life evaluation
- Current balance calculations to check for drain to connected structures
- Helps optimise CP retrofitting, offering substantial cost savings
- Reduces inspection time due to its non-contact feature

Where can you use FiGS?

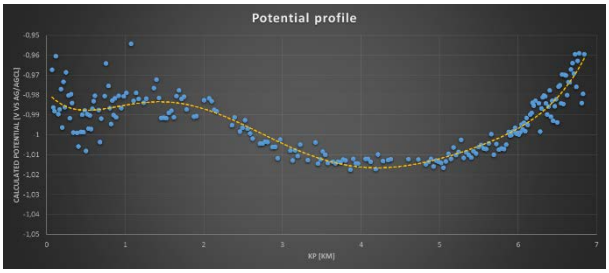
FORCE Technology can perform CP inspections of subsea systems in seawater, such as, but not limited to:

- Buried and exposed pipelines/flowlines
- Jackets
- Hulls (FPSO)
- Risers
- Wellheads / X-mas trees
- SSIV
- Manifolds
- Templates
- Umbilicals
- Mooring lines

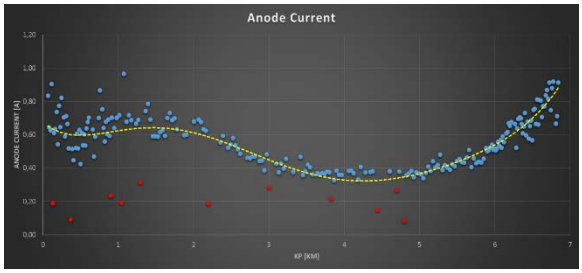
Typical results from FiGS Pipeline -surveys

The FiGS®provides accurate Field Gradient readings for exposed and buried pipelines. FiGS® data enables the calculation of several outputs, providing a good basis for evaluating the protection level, time to next inspection and remaining life. Typical content of a pipeline FiGS® survey report:

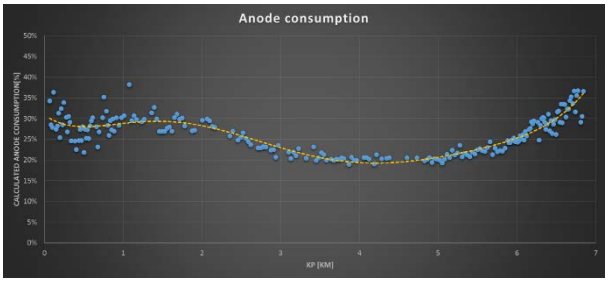
- Steel current densities
- Anode current outputs
- Potentials and potential profiles
- Anode wastages and remaining lives (if required)
- Coating defect assessment
- Identification of current drain from/to other structures



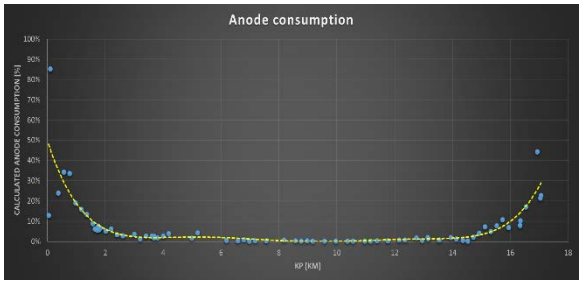
Potential profile for an exposed pipeline (Voltage vs KP)



Anode current for an exposed pipeline (Amps vs KP)



Anode consumption for an exposed pipeline (% vs KP)



Anode consumption for a buried pipeline (% vs KP)

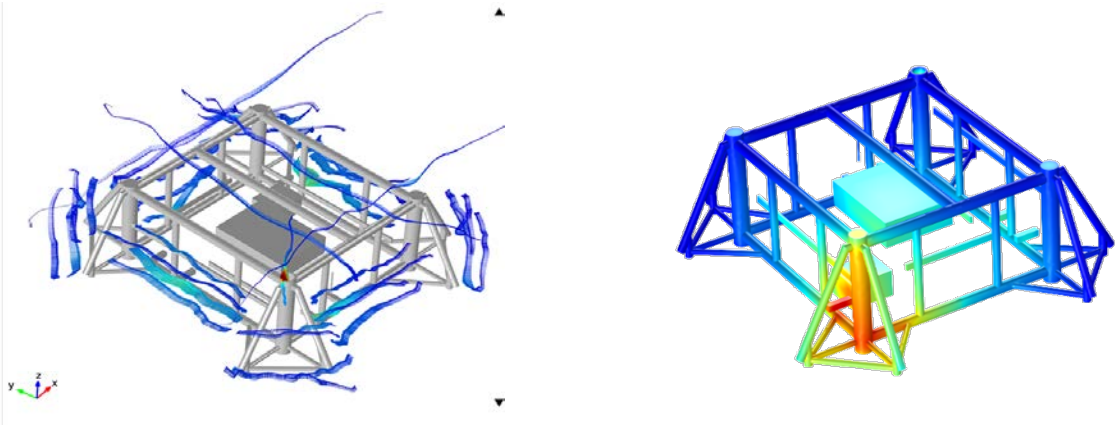
/ Figure 3 – Examples of results from FiGS pipeline survey

Typical result from FiGS Subsea structures 3D measurements surveys

FiGS® 3D measurement of subsea structures is very time efficient. Often there is no need to remove GRP covers or find suitable areas for point measurements. Combined with CP computer modelling, FiGS® will give complete potential distribution across the structure. A typical manifold or wellhead takes about 1 hour to inspect with FiGS® 3D, drastically reducing

vessel time offshore. Calculations show that the cost of inspection with FiGS® 3D including the post processing is in the same range as contact measurements, due to the reduced vessel time.

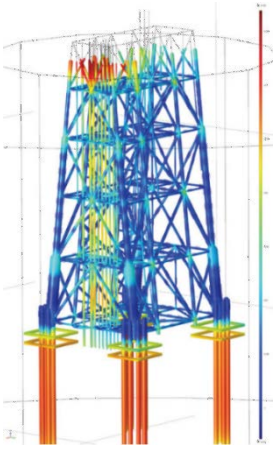
The 3D configuration of the FiGS® sensors will produce a very accurate field map around a structure (see figure below with field gradient vectors), providing a complete understanding of the current distribution around a complex structure.



/ Figure 4 – left; field strength direction and right; potential distribution

A 3D map of the electric fields surrounding the subsea structure will be generated from the 3D FiGS® data. This map is then used to calibrate a CP computer model of the structure. The resulting model parameters will then represent the actual state of the structure CP allowing the interpretation of the inspection results.

CP modelling (SeaCorr™)



With a strong theoretical basis, combined with field experience and databases with realistic field data (> 35 years), FORCE Technology has developed excellent competence in the field of service life extension. We provide cathodic protection modelling of all types of structures and pipelines. Our experts have developed a powerful software solution for this purpose, SeaCorr™, which can be used to simulate a wide range of structures. The main objective of CP modelling is to demonstrate the actual performance of a CP system. We simulate CP performance throughout its service life on structures, with or without coating, using sacrificial anodes, impressed current and hybrid systems. SeaCorr™ is an excellent tool to use when considering anode retrofit and life extension, as it utilises our unique database with real-life data in order to simulate the exact amount of retrofit anodes needed.

This comprehensive approach gives us a competitive edge with regard to the quality and reliability of our CP modelling results, and we can demonstrate large savings by using real-

life current densities as opposed to conservative design codes. We can also verify CP designs, using design code values.

In addition to using our real life database, we also utilise CP and Field Gradient inspection data, from FiGS surveys, in order to optimise the simulation results to the actual performance of the structure in question. Through our experience from CP inspection, evaluation and modelling of several structures over the last 30 years, it has been shown that actual polarization conditions most often deviate significantly from design parameters. e.g. lower current density level. Field gradient data may therefore give valuable input in addition to the SeaCorr™ database.

With CP modelling, you can try out different scenarios in order to ensure the optimal protection of your asset.

Typical cases evaluated by CP modelling:

- Current shadow effects, current drain and anode distribution issues
- Uneven anode consumption
- Over or under protection
- Protection in confined areas, small annuluses, gaps etc.
- Galvanic corrosion
- Anode interference
- Interaction between connected structures
- Pipeline attenuation

Cathodic Protection modelling and design (SeaCorr™)

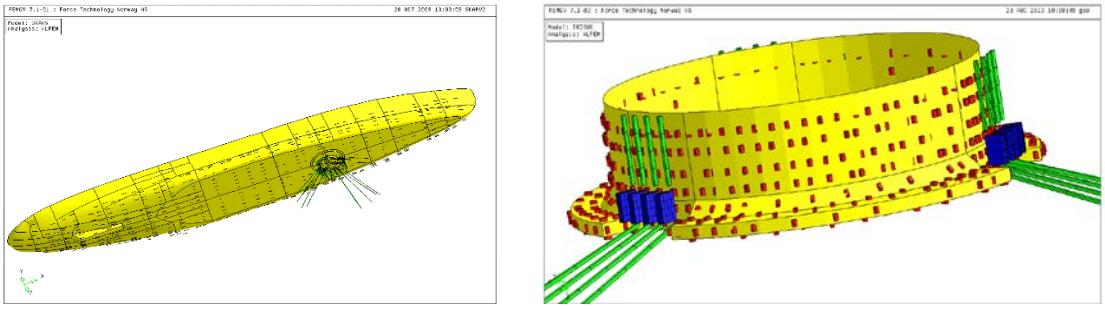
- Includes the world's largest database of actual offshore CP system performance
- Applicable to all types of CP systems
- Uses both boundary element (BEM) and finite element method (FEM)
- Enables global models of large and complex structures, such as jackets, TLPs, semi-submersibles, FPSOs, jack-ups and monopiles
- Combines CP inspection/monitoring with CP simulation in order to reduce inspection requirements
- Excellent tool to detect under and over protection
- Provides CP retrofit optimisation for life extension studies, with time step simulations combined with inspection/monitoring data to optimise/minimise the required number of new anodes

CP design

When designing a structure, whether it's a new one, a retrofit modification or a life extension, it is important to ensure full cathodic protection throughout its entire design life. This is achieved through a proper cathodic protection design, where the required amounts of anodes are calculated, and anode placement is determined.

We hold a large team of experts, with world leading experience from deep waters to onshore facilities, and from case studies to research and development. We provide CP design and evaluations of jackets, subsea structures, pipelines, FPSOs, semi submersibles, wind turbine foundations, caissons and other confined areas, chain connectors and more.

Our design and modelling experience combined with on-site inspection allow us to keep CP retrofit cost at a minimum, as well as ensuring optimal operation.



/ Figure 5 – CP model for FPSO design

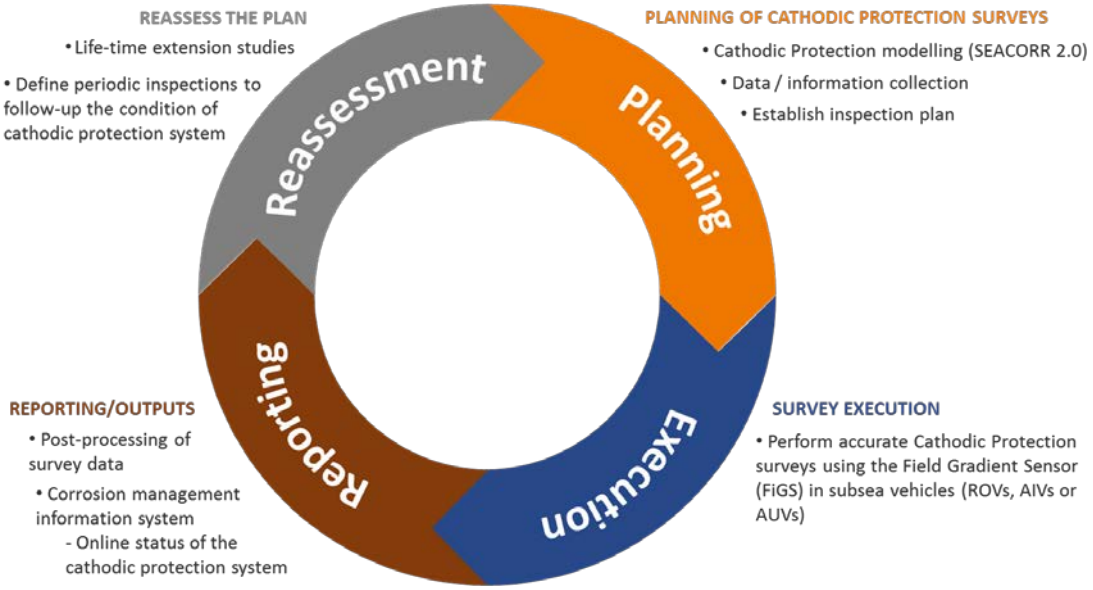
Our services within CP design include:

- Traditional CP design with both impressed current and sacrificial anodes
- CP design verification
- CP retrofit design
- Anode protection range and attenuation calculations
- CP design of stainless steels
- Material compatibility with cathodic protection systems.

CP management and consulting

Proper CP management is important and necessary to stay in control of the cathodic protection system. Staying in control may result in improved cost efficiency with regard to inspection intervals and prevention of otherwise unforeseen corrosion damages and breakdowns.

We offer full management of cathodic protection systems, including site inspection and inspection management, data analyses and reporting as well as various assessments of CP systems. The figure below illustrates our integrated management concept for CP systems.



/ Figure 6 – CP management

Cost savings

The FiGS technology has proven substantial cost savings at several levels, from more efficient and faster inspections, to eliminating the use of divers and excavation of buried or covered structures, when compared to alternative methods. The high quality mapping of field gradient data offered by FiGS has opened possibilities not only to predict the future performance and degradation of a CP system, thereby reducing the frequency of inspections, but also to pinpoint areas of interest, offering only necessary and coordinated intervention. Due to the added value and cost saving potential, several customers have now established FiGS as their standard CP Inspection tool, for everything from baseline to standard periodic and life extension surveys.

Extended life of offshore O&G fields often requires retrofitting of sacrificial anodes, and includes extremely expensive subsea operations. CP measurements alone cannot determine the remaining life of the anodes, but needs to be supported by current density measurements. The high sensitivity of FiGS gives a basis for rather accurate determination of

whether the anodes will last the remaining service life of the structure or not. If retrofitting is required, **the use of actual current density** levels instead of conservative specification data, will enable large cost savings. Customers that have used current FiGS have reported benefits such as:

Case:	Savings:
〉 **Using FG data together with CP modelling, instead of design codes, to optimise the retrofit of the CP system of a jacket structure**	〉 **~USD 10 million**
〉 **Economical savings and drastically reduced HSE risk by using FiGS instead of a traditional diving operation for performing an inspection of a subsea structure**	〉 **~USD 3-4 million**
〉 **Savings on a pipeline retrofit value by using FiGS data together with CP modelling, instead of design codes**	〉 **~50 % of total budgeted cost**
〉 **Again, savings on another pipeline retrofit value by using FiGS data together with CP modelling, instead of design codes**	〉 **~50 % of total budgeted cost**
〉 **Determining the status of inaccessible anodes underneath concrete mattresses**	〉 **Saving the cost of excavation, estimated at ~USD 500 000**

NORWEGIAN OFFICES:

Hvalstad: HEADQUARTER
Nye Vakås vei 32
1395 Hvalstad, Norway
Tel. +47 64 00 35 00
Fax +47 64 00 35 01
E-mail: info@force.no
www.forcetechnology.no

Harstad
FORCE Technology Arctic AS
Mercurveien 86
9408 Harstad, Norway

Trondheim
Hornebergveien 1
7038 Trondheim, Norway

Hammerfest
FORCE Technology Arctic AS
Leirvikhøyda 6
9610 Rypefjord, Norway

Kristiansand
Mjåvannsvegen 79
4628 Kristiansand, Norway

Bergen
Salhusvegen 55
5131 Nyborg, Norway

Stavanger
Luramyrveien 40
4313 Sandnes, Norway

GLOBAL HEADQUARTERS:

FORCE Technology
Park Allé 345
2605 Brøndby, Denmark
Tel. +45 43 26 70 00
Fax +45 43 26 70 11
E-mail: info@forcetechnology.com
www.forcetechnology.com

FORCE Technology Sweden AB
Tallmätargatan 7
721 34 Västerås, Sweden
Tel. +46 (0)21 490 3000
Fax +46 (0)21 490 3001
E-mail: info@forcetechnology.se
www.forcetechnology.com/sv