

## **Paint and corrosion protection measurements using innovative technology**

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**Report-series on coating thickness measurement under difficult conditions**

**Series headline:**

**Coating thickness measurement – state of the art:**

**Paint and corrosion protection measurements using innovative technology**

Part 1.

**An up to date overview: innovation in corrosion protection measurement**

International competition constantly challenges manufactures of corrosion protection and coating thickness measuring technology.

Growing demands on flexibility, reliability, accuracy and the requirements of qualified users world wide concerning increased productivity and value creation lead to new and innovative measuring systems.

Particularly modular gauge systems with single components suited for various measuring tasks provide high flexibility and reduce cost significantly. The modular QNix® 8500 measuring system is one example of the flexible and cost reducing use of such a system by users, worldwide.

Measuring probes for duplex measurements of various coatings or novel pen-shaped probes for coating thickness measurement on small parts and edges increase reliability and productivity in quality management.

State of the art transmission technology used to transmit readings – for example with a wireless probes – expands the areas of practical application in the lacquer and anti-corrosion coating measurement, increasing work efficiency at the same time.

At the end of the day, innovative and system-integrated measuring gauges such as the new CarCheck system providing menu-guided recording, analysis and documentation of all paint measurements offer completely new areas of applications within the automobile industry.

Until now, usual paint coating gauges have been developed for specific measuring tasks and areas of application.

Thanks to the current developments made by AUTOMATION Dr. Nix, Cologne, Germany – one of the world's leading manufacturers of hand-held gauges – coating thickness measuring technology is now being used in the paint and automobile industry, when inspecting corrosion protection, building large steel structures, renovating bridges, and overhauling ships or in the quality management of energy providers for inspecting pylons.

From a user's point of view and from experience in practical use, the following series of reports provide an up to date overview of the advances made in measurement technology, gauges, and systems. Particularly, regarding its use with optimized lacquer coating measurements, quality control and improved corrosion protection.

The series of articles „Coating thickness measurement – state of the art” informs you about current and future demands on technology required by new international standards.

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**Coating thickness measurement – state of the art:**  
**Paint and corrosion protection measurements using innovative technology**

Part 2:

**Innovative system-solutions expand the application of coating thickness gauges in the area of corrosion protection**

Experts worldwide demand small, practical, and reliable gauges due to the growing international concern regarding standardized inspections of corrosion protection in particular. Modern coating thickness gauges can now be used in various measuring conditions when combined with modular measuring systems, interchangeable probes and innovative technology in the area of transmission, memory and analysis.

Therefore, modularly designed systems providing non-destructive coating thickness measurement have proven to be of particular value when dealing with the inspection of paint and corrosion protection. These systems help users to resolve measuring problems and to achieve different measuring tasks in an excellent manner.

The German company AUTOMATION Dr. Nix in Cologne specializes on precise and easy-to-use hand-held gauges. In close cooperation with users around the world, the company has developed practical and reliable measuring systems offering easy and accurate solutions for the most different types of measuring tasks.

This holds particularly true to the handling, robustness, and precision of the gauges under difficult conditions.

**Real life challenges for hand-held gauges**

In the long run, even a hand-held gauge may be too bulky or too heavy during long-term practical use – for example when measuring corrosion protection of bridges, ships or large steel structures. A user who has to take a large number of measurements on a vast surface for example, exerts a lot of physical effort and fatigues easily. Measuring errors may sneak in, possibly leading to complaints and complicated re-measurements resulting in increased costs.

Another problem of conventional devices is that although usually relatively small they are still too large when equipped with memory, batteries and display; especially for complicated measurements in close spaces.

While today's cable-connected measuring probes have a measuring tip that is significantly smaller, lighter and more mobile than the actual gauge, thus offering a high degree of flexibility facilitating difficult measuring tasks significantly, the cable-connection between probe and gauge still hinders the user. Such a hindering connection however is a constant source of danger, especially when the user needs at least one free hand to hold on to a handhold, or to climb a ladder or a pylon for example. Wireless measuring probes provide a solution for such problems, increasing work efficiency with their new measurement mobility.

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**Coating thickness measurement – state of the art:**  
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Part 3:

**Wireless coating thickness measurements, even where „only the thump fits“**

Now, a just thump-sized and 30 grams light wireless probe allows coating thickness measurements to be taken under difficult conditions and on difficult to access spots. The world novel miniature wireless probe QNix® 8500 now guarantees a mobility of coating thickness measuring that you have never before experienced. Take measurements of paint and corrosion protection on difficult to access yet crucial spots independently from the gauges and transmit the readings wirelessly to a PC, saving them for later analysis.

Measure now „where ever the thump fits“.

Thanks to the wireless measurement transmission via radio

Precise one-hand measurements are possible even on vast measuring surfaces or if you measure in high altitudes while still needing a complete documentation of all your readings.

**Modular precision measuring system offers many user advantages**

With the wireless transmission of measurements to the gauge of the modular QNix® 8500 measuring system, the new thump-sized wireless probe offers enormous versatility in its use:

Simply adjust the gauge to any measuring task within a measuring range of 0 – 5000 µm by simply changing the probes.

Use the easy-to-use software provided by Automation Dr. Nix for statistical analysis and documentation purposes.

**A new mobility of measurement revolutionizing the coating thickness measuring technology**

QNix® coating thickness gauges are light, small and manageable. However, for users to get even closer to difficult to access measuring spots, AUTOMATION Dr. Nix, Cologne has developed an all-new coating thickness gauge – a thump sized, 30 grams light miniature wireless probe.

The new wireless probe QNix® sat allows for one-hand measurements even in extremely tight spaces, where conventional gauges do not fit. For example, when measuring lacquer, corrosion protection or for inspection purposes during renovations, or when building bridges, planes and ships.

As a part of the modular QNix® 8500 precision measuring system, the worldwide novel QNix® 8500 sat wireless probe offers completely new applications in the area of coating thickness measurement. An innovation “Made in Germany”.

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**Coating thickness measurement – state of the art:**

**Paint and corrosion protection measurements using innovative technology**

Part 4:

**Reducing the cost of determining coating thickness using application-oriented measuring probes such as the magnet-inductive pen-shaped probe**

State of the art modular measuring systems provide the foundation of the flexible and versatile use of application-specific measuring probes.

Therefore, the new precision measuring system QNix® 8500 has been developed particularly to measure different kinds of paint and corrosion protection. The modular connector system of the specifically designed interchangeable probes offers highest flexibility and cost efficiency. Depending on the measuring task, you can choose to use different kinds of measuring probes. Transmit their readings reliably – even wireless, display them accurately, document them or process them for optimum statistical analysis. Latest modular measuring probes such as the wireless probe for transmitting measurements wirelessly, or the new magnet-inductive pen-shaped probe for precision measurements of micro-coating thickness on small parts, extend the areas in which modern corrosion protection measurement can be used. They optimize the quality management of major building projects and increase productivity, thus significantly reducing the cost.

In addition to standard probes based on the Hall-sensor principle, AUTOMATION Dr. Nix – specialized on non-destructive coating thickness gauges – now offers a new magnet-inductive pen-shaped probe with a measuring range between 0 and 500 µm. The new interchangeable probe measures even particularly thin non-ferromagnetic coatings on small parts extremely precise within the lower measuring range. With this additional tool for precision measurement of thin coatings, the pen-shaped probe provides new areas of application in the quality management of small parts or when measuring close to edges.

**Quality control with precision measurements of micro coatings on small parts**

In practice, small steel parts such as screws or bolts are coated with a layer of corrosion protection. Only the right coating thickness, usually within the lower micrometer range, guarantees good adherence as well as proper corrosion protection. Now, the newly optimized QNix® pen-shaped probe MI Fe 500µm reduces interfering measuring effects on edges significantly. That way, you can take readings more closely to edges to ensure better measurement on small parts. This guarantees, a reliable quality control of corrosion protection on small surfaces or near edges. Furthermore, coating thickness measurements of thin, non-ferromagnetic metal coatings such as chromium, copper, zinc are now just as possible on steel substrates as measurements of PVD coatings, paint, enamel or synthetic coatings and many others. Our devices take their precise measurements based on the magnetic inductive measuring principle and in accordance with the DIN EN ISO 2178, ISO 2808 and ASTM B499 standards. In addition, the pen shape of the latest probe offers optimum control over the manual adjustment on the measuring object. If the requirements on accuracy are particularly high, the new measuring probe can be mounted on a measuring stand.

Sample holders, to be used with the stand are also available.

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**Coating thickness measurement – state of the art:**  
**Paint and corrosion protection measurements using innovative technology**

Part 5:

**Statistics and documentation of coating thickness measurements for optimized quality management**

Today, coating thickness gauges with statistics and recording features are essential in the practical quality management of large building and renovation projects; or where ever many measurements have to be taken and documented. In addition to gauges without statistics feature, which will in future still be needed for standard measurements, modern gauges and measuring systems providing such a feature are required for measuring in accordance with standards, when inspecting major projects such as ships, bridges or large steel structures where several thousand measurements have to be taken.

The wireless transmission of coating thickness measurements to a PC offers a fast, reliable, flexible, and convenient way to process readings for statistical purposes. That way the gauge's plugs keep clean in the rough everyday conditions and do not causing any problems. You can directly analyze all measuring data in a structured manner, print it or send it to project partners via internet.

Furthermore, these modern gauges allow for measurements to be recorded fast and in an ordered manner according to location and time.

Thus, the inspections of each coating thickness of the multi layer systems usually applied, are being documented according to each job. This provides a highly efficient work environment, improving the efficiency of the quality management.

These important additional features are also integrated in the newly developed color coat measuring system, the CarCheck system from AUTOMATION Dr. Nix. It guarantees easy, fast, and reliable menu driven recording, processing and documenting of all coating measurements. For the purpose of quality management and damage assessment of insurance claims within the car trade and automobile industry, state of the art measuring systems offer a faultless analysis and documentation that can clarify without a doubt if a "particularly thick" coated part may be the result of an unprofessionally repaired accident. Such documentation is particularly helpful when dealing with high damage sums or when presenting proof before court. Insurances will be unable to forego such documentation solutions in the future.

The laboratories of coating manufacturers will also come to recognize the increased demands on quality management in future. They will make any effort to optimize their products, paint quality and coatings to meet the coat and quality requirements of manufacturers. Therefore, they will realize the increasing importance of precise definitions and systematic documentation of various coating thicknesses. The world novel CarCheck system offers the quality management of all areas of the automobile industry new prospects regarding accuracy, reproducibility, and the integration of procedures and productivity.

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**Coating thickness measurement – state of the art:**  
**Paint and corrosion protection measurements using innovative technology****Part 6:****Duplex measuring systems for the inspection of multi-layer systems in coating thickness measurement**

Modern coating materials, especially applied in multiple layers provide reliable corrosion protection. In this regard, crucial steel structures such as „bridge railings“ are protected with a duplex coating system based on a galvanized and an epoxy based coating. To ensure the protective function of the coating materials used, their impermeability against affecting media is of importance. If pores exist, subsurface corrosion may spread from there and destroy the coating. Therefore, steel structures that have to be protected for a long time are painted with several layers of coating. In addition to the careful selection of appropriate coating material, the quality of the coating procedure is essential for the durability of the applied coatings. To guarantee the quality of the duplex systems i.e. the coating thickness of the galvanizing and the epoxy-based layer on the steel surface, both layers have to be inspected and measured using special gauges providing a combined duplex measuring mode.

Coating thickness gauges such as the QNix® 8500 measuring system offer a specially combined measuring mode. A convenient way to measure the galvanizing and the upper epoxy-based layer in one single measuring process and to record the readings. Thus, you can analyze the coating thickness of both layers at the same time.

In addition to multi layer measurements, the interchangeable probes from AUTOMATION Dr. Nix offer further advantages for an efficient quality control using wireless measuring technology.

Working on large steel structures such as pylons or antennae, where corrosion protection can only be inspected while climbing, QNix® Keyless gauges and the new modular measuring system QNix® 8500 have proven to be of particular value, because their very small measuring probes are equipped with a wrist warp allowing to use both hands for climbing.

This enables you to inspect the coating thickness completely and efficiently directly on the object – even with duplex probes or combined measuring probes. Particularly fast, convenient, and small measuring probes such as the radio-based thumb-sized QNix® 8500 sat or QNix® Keyless measuring probes enable you to take your readings in many situations, even under difficult conditions such as working on pylons without any cables hindering you in your work. The coating thickness is being determined accurately and fast, for example with the only 30 grams light QNix® wireless probe. It can document the readings for later statistical analysis. An advancement that significantly facilitates the practical use as well as quality-cost-management and work efficiency.

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**Coating thickness measurement – state of the art:**  
**Paint and corrosion protection measurements using innovative technology**

Part 7:

**Corrosion protection in accordance with standards**

The cost of corrosion protection is relatively low when compared to the possible obsolescence of the structure that is to be protected and the cost caused by a possible operation shut down. In the US for instance, the annual cost of damages due to corrosion are estimated at 4% of the US' gross national product (515 billion US-Dollars). (*Source: Fraunhofer Institut für Fertigungstechnik, brochure 2804*) This enormous sum includes - within the limits of the study - in some branches of industry primary corrosion damage (cost of general overhauls and ongoing repairs due to corrosion) as well as secondary damages (such as breaking of pylons and the power outage caused by it) and the cost of the corrosion protection and its inspections. In Germany, the cost of damages caused by corrosion also amount to billions. 20 years ago, the cost of corrosion damage was reported to amount to about 70 billion DM (without secondary damages) which was about 4.5% of Germans gross national product of that time. Today the cost is significantly higher. At 4% of German's GDP which is about 70 billion Euros (*Source: Flyer Corrosion Protection of the University of Applied Science Ostwestfalen, Iserlohn*). Therefore, the issue of corrosion protection and its inspection using modern coating thickness gauges is increasingly important to the industry worldwide. Numerous rules and regulations support the constant effort to avoid and minimize corrosion damage for instance with the DIN EN ISO 12944. Corrosion protection measuring devices have to work in complete accordance with these standards.

**Standards for inspecting coating thickness serve to protect steel structures**

As many steel structures have such an important function, the DIN EN ISO 12944 Part 7 „Corrosion protection of steel structures using coating systems“ regulates the completion and monitoring of coating procedures, including, under item 6.3, the inspection of dry coating thickness with measuring procedures or principles according to EN ISO 2808. This standards includes, under item 5.5.6, the magnetic measuring principles of AUTOMATION Dr. Nix based on the measurement of magnetic field variances with Hall-sensors as well as eddy-current measurement principles. Furthermore, such corrosion protection and coating thickness gauges are particularly advantageous and practical when easy to calibrate and to use. The easy and reliable operation of rugged hand-held coating thickness gauges from AUTOMAION Dr. Nix for the use in everyday situations, is only one of the important features that guarantee a reasonable use in quality management of major projects.

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**Coating thickness measurement – state of the art:**  
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Part 8:

**State of the art coating thickness measuring technology optimizes the quality management of laboratory, paint and production technology**

When manufacturing and developing paints and lacquers, many varying parameters lead to different characteristics of the final coating. Some of these characteristics are influenced by the coating's thickness and the paint or lacquer applied.

Efforts of manufacturers to achieve characteristics of high quality and decoration using less material led to reduced coating thickness. An important reason to inspect such coatings precisely and reproducibly. In order to measure the simple coating thickness of wet film, so called wet film measuring combs are used that are dipped into the paint film down to the substrate surface.

When determining the coating thickness of dry coating, non-destructive measuring electronic gauges are used that display the desired measurement fast and precise, based on magnetic procedures such as the Hall effect or the eddy-current.

Especially the modular QNix® 8500 measuring system can easily be adjusted to each measuring task – even duplex measurements – on the most different types of measuring substrates when combining various measuring probes. The wireless transmission of measurements via radio from probe to gauge is also possible.

**Quality management during development and production using statistical analysis**

To ensure the monitoring of quality in laboratories and production, coating thickness gauges and systems are required that provide advanced features for documentation and statistics in addition to simply taking a measurement. The statistical analysis of the measurements taken concerning average, standard deviation, minimum and maximum value offers an overview about the quality of complete production batches. This allows successful measures for increasing quality and process capacity to be quickly implemented. The documentation of measurements is achieved by simply transferring data to a PC and saving it for further analysis using a spreadsheet program. This provides a reliable, fast and convenient working method. The new modular QNix® 8500 measuring system for instance, transmits measuring data using a convenient wireless connection to a PC. As no interface connections are exposed, the transmission of measurements is safe from dirt and damage.

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**Coating thickness measurement – state of the art:**  
**Paint and corrosion protection measurements using innovative technology**

Part 9:

**An innovative „revolution“: the CarCheck measuring system from AUTOMATION Dr. Nix, adding a new level to the measurement and inspection of paint coatings**

The worldwide novel CarCheck system for measuring lacquer coatings is a menu driven quality system, which already works in accordance with future rules and regulations of the automobile industry concerning the taking, analyzing, and documenting of measurements. Based on proven technology, the application oriented advantages and features have been developed further. That way, a state of the art rugged, easy-to-use, and reliable measuring system has been created, providing a large measuring range and an innovative software solution to facilitate inspection work.

**Menu-driven recording, analysis, and documentation of lacquer coating thickness measurements in the automobile industry**

Using the new CarCheck measuring system for easy, fast, and reliable menu-driven measurements of paint coating thickness, provide the automobile industry with completely new possibilities of cost, quality and damage management. The structured design of a measuring task, the systematic documentation of measurements and the measurement value analysis in combination with intelligent menu navigation are essential advantages.

**Strong demands on cost and quality management in the car trade require new, complete, and innovative system solutions**

AUTOMATION Dr. Nix reacts to the increasing quality requirements of industry, craft, service providers, experts, insurances, leasing providers and carmakers, providing an extensive, detailed, and provable documentation of measurements. Now for the first time, these high and individual requirements of international users concerning speed and reliability of the structured recording of measurements, their analysis and documentation can be met using the new CarCheck measuring system.

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**Coating thickness measurement – state of the art:  
Paint and corrosion protection measurements using innovative technology**

Part 10:

**New IMO-standards for the inspection of anti-corrosion coatings in shipbuilding***International standards focusing on the inspection of thickness of ship's coatings.*

Past maritime disasters caused by enormous corrosion damage [4] bring IMO, classification societies, ship owners as well as shipyards to realize the importance of corrosion protection of ships. Modern coating thickness gauges such as the modular QNix® 8500 measuring system offer a fast and accurate inspection of corrosion protection as well as efficient and convenient documentation of measurements using a PC.

Especially since the implementation of the „Coating Technical File“ which is to be kept during the complete service life of a ship, this system allows the required coating thickness measurements to be analyzed and documented individually by the various organizations involved.

The high quality of the coating thickness gauges from AUTOMATION Dr. Nix, which are being manufactured in Germany exclusively, the fast customer oriented service as well as easy and individual data processing guarantee users a high degree of productivity, flexibility and increase in their value creation.

**Report on the use of modern coating thickness gauges for ship inspections and the latest related IMO-standards**

The quality of coatings in the ship building industry is increasingly subject to international regulations, because protective coatings reduce corrosion and thus increase a ship's stability [1], [2], [3].

Especially the ballast water tanks of a ship are of particular importance here, because these tanks are prone to corrode easily and any danger to the ship's structure due to corrosion damages is difficult to assess while the ship is being used. In this regard, the first international conventions for preventing corrosion have been implemented: the “Safety of Life at Sea” (SOLAS) Reg. II-1/3-2 regarding ballast water tanks and double hulls, resulting in the extensive IMO-resolution MSC215(82) including the “Performance Standard for Protective Coating PSPC.

The standard aims to provide a constant quality of coatings lasting 15 years of service life. It applies to all ships with more than 500 gross registered tons concerning their ballast water tanks and to double hull ships with a length of at least 150 meters with building contracts dating later than July 1, 2008. In accordance with the latest IMO-regulation, the International Association of Classification Societies IACS issued procedural requirements (IACS PR 34) that demand a complete documentation of work in a so-called “Coating Technical File” (CTF). The CTF has to be kept on board the ship during its complete service life and contains specifications of the coating system, documentation of the shipyard as well as the ship owner concerning inspection, maintenance, and repair work.

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This brings about new challenges for shipyards and ship owners as well as for classification societies, because according to items 6.1.1-3 of the latest IMO-resolution, the measuring results have to be documented into the CTF by an accredited expert.

**Essential: Precise and efficient analysis of coating thickness measurements in practical use**

In regard to quality control the generally epoxy-based coating, coating thickness has to be evaluated in accordance with the 90/10 rule as required by the IMO-standard MSC215(82). This 90/10 rule specifies that 90% of all measurements have to be larger than or equal to the reference thickness and that the remaining 10% of measurements must not be smaller than 0.9 times the reference thickness [5]. In addition to that, shipyards refer to the DIN EN ISO 12944-5 [6] especially when dealing with rough surfaces. Since January 2008, this standard refers in its controversial Part 5 to ISO 19840 and ISO 2808 [7], [8]. In addition to the qualifications of personnel according to training standards such as the FROSIO or NACE, fast and reliable gauges are necessary to take for instance about 40,000 measurements a day in rough environmental conditions and on difficult spots. With regard to the reliability of several thousand coating thickness measurements taken each day, the specifically treated ruby measuring heads of the interchangeable probes of the QNix® 8500 measuring system offer an excellent wear resistance, because rubies provide a significantly higher durability than any metal overlay.

In shipyards, building a ship is organized in so-called ship sections that are coated and measured separately before assembly. The structured recording of individual sections can be saved to individual named batches.

The fast and structured taking of measurements of each individual layer of the usually used multi-layer systems, depending on location and time is essential, because it provides an efficient working method and thus ensures highly efficient quality management. The extensive analysis and documentation of measuring data for the "Coating Technical File" can conveniently be processed with a PC. To this end, wireless measurement transmission from gauge to PC is available. Thanks to direct transmission of measuring data to Microsoft Excel, the user can analyze the data for statistical purposes according to his requirements and document it individually for the use in the "Coating Technical File". Together with the spreadsheet program, the QNix® 8500 measuring system provides a convenient tool offering a complete solution, including measurement, analysis, and documentation for fast and thus efficient processing of measuring data and its documentation in those institutions that are responsible for building, inspecting and verifying. This will be even more important in the future, when the IMO regulation MSC Res. 244(83) will presumably make the documentation of repair and maintenance work of ships of more than 500 gross registered tones mandatory.

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