CEFRACOR
CENTRE FRANÇAIS DE L'ANTICORROSION

Committee for Cathodic Protection and Associated Coatings

RECOMMENDATION PCRA 003

Octobre 2003 – Rev.0

Recommendation for the inspection by electrical method of faults in on-site or factory applied organic coatings on steel

DISCLAIMER: The present recommendation has been consensually established by the members of the committee "Cathodic protection and associated coatings" of CEFRACOR. It reflects the general opinion in the trade and might be used as such as a basis representing at the best the state of art at the date of issue. Nevertheless, it shall not commit in any manner the CEFRACOR and the committee members by whom it was established.

1. SCOPE

The purpose of this document is to propose a method of non destructive inspection of punctures in organic coatings applied on steel.

The concerned faults are cracks, conductive inclusions and pinholes.

The proposed methods can only be relevant if the coatings are electrically insulating .

This document was prepared by the Committee for Cathodic Protection and Associated Coatings of CEFRACOR.

2. PRINCIPLES

The principle of the method is based on the application of an electrical potential between the metallic support and a mobile electrode positioned at the surface of the coating to be inspected. The coating being the insulation due to its dielectric features.

There exist two methods that are currently used :

- the inspection at low electrical potential, using water in contact with the external surface of the coating, by means of a humid sponge
- the inspection at high electrical potential, using the air in contact with the external surface of the coating to be inspected.

A fault in the coating allows the flow of a current between the electrode and the metallic support through the air or the water. This current flow is revealed through a visual or audible signal.

The limit is given by the breakdown potential of the dielectric composed by the coating.

3. METHODOLOGY

The choice of the inspection potential is important to avoid to deteriorate the film. As a matter of fact, an excessive potential leads to the deterioration of the film and entails the formation of cracks. The inspection potential shall therefore be adjusted depending on the type of coating and the thickness.

In the case of a coating applied in accordance with a standard, its recommended inspection requirements shall be complied with.

Nevertheless, it is always recommended to consult the manufacturer of the coating, in order to define the suitable inspection potential.

The table below shows the recommended potentials according to certain standards.

Inspection at low electrical potential: method of « the humid sponge ».

The inspection shall be carried out on a clean, dry and reticulated film. A solvent retention in the film could form an electric path to the support.

The detection at low voltage is carried out by means of a humid sponge. The method is recommended for coatings of which the dry thickness is less than 500 µm. For thicknesses exceeding 500 µm it is not recommended to use the detection at low voltage which turns out to be inaccurate.

The potential generator is composed of an accumulator which develops a continuous voltage in the range of 5V to 90V.

- The conducting part of the support shall be connected to one terminal of the generator
- The sponge is connected to the other terminal of the generator
- The humid sponge shall be put in contact with the coating
- The sponge shall be saturated with city water.

The sensitivity of the detection can be improved by adding some surface active to the water.

For multi-layer coatings, when a porosity inspection is foreseen for each layer, it is not recommended to use water with a surface active added. The surface active will be a contaminant which may affect the adhesion between layers.

The sponge in contact with the surface of the coating shall be moved at a maximum speed of 0,3 m/s.

Expression of the results

The fault (pinhole, crack) is revealed by means of a visual or audible signal which indicates the flow of a current between the electrode and the pipe.

Inspection at high electrical potential : method of the « holiday detector ».

The inspection method at high potential, also referred at as holiday detection, is recommended for films with a thickness exceeding 300 µm.

Typical values of commonly used potentials are respectively:

- Medium thick coatings : 300 µm to 1000 µm Voltage of 5 V/µm
- Thick coatings : exceeding 1000 µm Voltage of 10 V/µm (< 20 kV)

The inspection with the holiday detector of coatings with a thickness less than 300 µm is possible but risks to deteriorate the film. The high voltage detection apparatus is composed of :

- a power source
- a sensor electrode (brush, broom, ring of electrical conducting rubber, spring of which the spacing between the windings shall be less than the thickness of the coating)
- a grounding system connected to the apparatus (grounding of one of the terminals of the generator and the extremity of the pipe)

The high voltage inspection device can be a system a pulsed electrical discharge or of continuous electrical discharge.

The inspection voltage shall be adjusted so as to be able to detect a pinhole of which the size correspond to the thickness of the coatings.

A practical way to determine this voltage is to place on a steel plate a calibration wedge of insulating material of which the thickness correspond to the maximum thickness of the coating.

Using the wedge as a standard, the minimum voltage is determined for which an arc is obtained in the air between the plate and the sensor electrode.

For the inspection on a building site, the value of the voltage shall take into account the maximum thickness of the coating as well as the breakdown characteristics of the least insulating coating (generally the one on the welding joints).

The metallic part of the sample to be examined shall be connected to the ground of the device.

The sensor electrode is put in close contact with the conducting part of the sample to be examined in order to check the formation of a spark indicating that the grounding is correct.

This verification shall be carried out periodically during the inspection of the coating.

The sensor electrode in contact with the surface of the coating shall be moved at a maximum speed of 0,3 m/s .

Expression of the results

The flaw (crack, pinhole) in the coating is detected by an electric arc that forms between the sensor electrode and the metallic support.

Inspection voltage of the holiday detector

according to the type of coating

Type of coating	**Specification**	**Unit voltage**	**Maximum voltage***
Polyurethane	Pr EN 10290	8V/µm	20000V
Liquid epoxy	Pr En 10289	8V/µm	20000V
Epoxy powder	NF A49-706	5V/µm	
Three-layer PE	NF A49-710	Spark adjustment	
Three-layer PP	NF A49-711	10V/µm	25000V
Coal tar	Pr EN 10300		Between 18000 V and 22000 V
Two-layer polyamide	Pr EN 10310	10V/µm	

*For the entire thickness of the coating

Coatings on the girth weld joints : NFA 49-716

Tapes of bitumen/coal tar	**Thermo-shrinkable**	**Polyurethane**	**Liquid epoxy**	**Polyamide**	**Epoxy powder**
10KV	5V/µm	5V/µm	5V/µm	5V/µm	5V/ µm

4. IMPORTANT RECOMMENDATIONS

The inspection shall be carried out on a pipe which is clean, and dry in the case of the method at high voltage.

The presence of conducting particles in or on the coating (water, salt, metallic particles,…) may modify its electrical characteristics and lead to false alarms or to a faulty localization of the flaw.

It must be avoided to inspect several times the same area, as consecutive passages of the holiday detector may lead to the deterioration of the coating, even if the voltage is adequately adjusted.

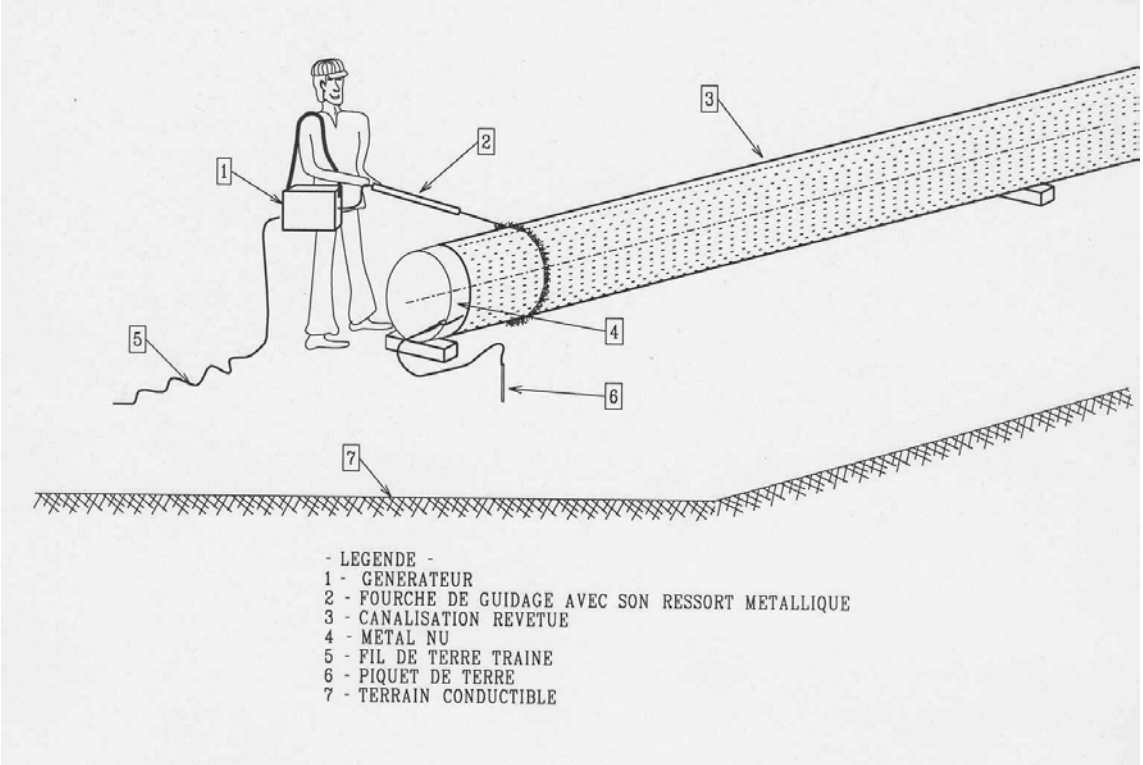
5. REFERENCE DOCUMENTS

NACE RP 0188 : Discontinuity (Holiday) Testing of new protective coatings on conductive substrates

NACE RP 0274 : High voltage electrical inspection of pipeline coatings prior to installation

NACE RP 0490 : Holiday detection of fusion-bonded epoxy external pipeline coatings of 250 to 760 micrometers (10 to 30 mils)

ASTM D 5162 : Practice for Discontinuity (Holyday) Testing of Nonconductive Protective Coating on Metallic Substrates



Principle of inspection with the « holiday detector »

1 - Generator
2 - Guiding stick with its metallic spring
3 - Coated pipeline
4 - Bare metal
5 - Trailing grounding wire
6 - Grounding pin
7 - Conducting soil