CEOCOR 2006 – Mondorf-les-Bains - Luxembourg

30th May – 2nd June 2006

SECTOR A - Paper A12

Quality and Safety in Natural Gas Distribution in Italy
APCE Guidelines

Qualité et sécurité du réseau de distribution de gaz naturel en Italie - Recommandations APCE

Qualität und Sicherheit bei der Erdgasverteilung in Italien – Richtlinien der APCE

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Abstract
Italian gas distribution networks are nowadays mainly constituted by steel pipes (85%) and cathodic protection is a necessary condition to guarantee security of service to the costumers and safety to the population against damages that can lead to gas leakage, bursting or fire.
This paper deals with Italian national standardization and APCE guidelines on cathodic protection in the framework of the resolution nr. 168/04 “Unified Code of Authority for Electricity and Gas Provisions Concerning Quality of Natural Gas Distribution, Metering and Supply Services” issued on Sept. 29th 2004”.
The resolution has the aim of giving rules for a correct behaviour of gas distribution Companies and of monitoring the continuous and effective application of these rules to guarantee prevention of corrosion phenomena which can impair the safety of gas distribution networks.

Résumé
De nos jours, les réseaux de distribution de gaz italiens sont principalement composés de canalisations en acier (85%) et la protection cathodique est dès lors une condition sine qua non pour garantir la sûreté du service aux clients et la sécurité de la population vis-à-vis des dommages pouvant mener à une fuite de gaz, à une explosion ou à un incendie.
Ce document porte sur la standardisation nationale italienne et les directives APCE en matière de protection cathodique dans le cadre de la décision n° 168/04 “Unified Code of Authority for Electricity and Gas Provisions Concerning Quality of Natural Gas Distribution, Metering and Supply Services” (“Code d’autorité unifié pour les approvisionnements en gaz et électricité concernant la qualité du comptage, des services d’approvisionnement et de la distribution de gaz naturel“) parue le 29 septembre 2004.
La décision vise à fixer des règles de bonne conduite pour les entreprises de distribution de gaz et à contrôler l’application continue et efficace de ces règles afin de garantir la prévention des phénomènes de corrosion susceptibles de compromettre la sécurité des réseaux de distribution du gaz.

1. INTRODUCTION

The risks of corrosion of buried steel pipelines for gas distribution caused by the external environment are high; that’s why these important assets must be protected against corrosion phenomena, potential cause for damage to properties, persons or to the environment without ignoring economical losses for the distribution company in case of pipeline reduced operation.
Hence, protection against corrosion of steel pipelines must be taken into account right from the design phase with the selection of suitable protective coatings and implementing cathodic protection with a wide range of systems and equipments.
Other important aspects for an effective cathodic protection are both regular inspections and maintenance which grant the correct and constant functionality of equipment and accessories, as well as regular measurements over time to ascertain the value of protection potential over the entire pipe surface.
Inspections and periodic checks allow the discovery of any possible anomaly and the definition of the actions needed to promptly restore the state of electrical protection.
There is no point in having a well-designed and well-built network if not used under safe conditions and with good and regular maintenance.

In this context, the Italian Authority for Electricity and Gas (AEEG) in the Resolution nr. 168/04 “Unified Code of Authority for Electricity and Gas’s Provisions Concerning Quality of Natural Gas Distribution, Metering and Supply Services”, reconfirmed, amongst the different aspects of technical quality in the distribution service, that the implementation and management of cathodic protection in steel networks are factors determining the safety and continuity of the service.
This report summarises the AEEG Resolution, its regulatory aspects and three guidelines prepared by the APCE (Associazione per la Protezione dalle Corrosioni Elettrolitiche, “Association for the Protection from Electrolytic Corrosion”) and published by the UNI, regarding the cathodic protection of metallic pipelines in gas distribution systems.

2. AEEG RESOLUTION 168/04

Following the positive results obtained during the first regulatory period with Resolution 236/00 for the technical quality of gas distribution, on Sept. 29th 2004 the AEEG issued Resolution 168/04 “Unified Code of Authority for Electricity and Gas’s Provisions Concerning Quality of Natural Gas Distribution, Metering and Supply Services” (published on Official Gazette No. 245 dated Oct. 18th 2004, ordinary supplement 158), collecting previous resolutions in a unified and updated text, in some parts also involving the activity of the APCE.
The appointment the Authority granted to APCE represents the official acknowledgement of a long process that, over the years, involved the Association in activities of analysis, research, training, communication and contribution to staff qualification and certification.
In Resolution 168/04 the Authority underlined that cathodic protection of buried steel pipelines is a fundamental and mandatory criterion for an effective network conservation and for the protection against corrosion thus granting the safety standards.
It should be remembered that currently buried steel pipelines constitute more than 85% of the total gas distribution network; consequently it turns out that cathodic protection has a great importance as pre-requisite for safety of the distribution service and for protecting people or properties from the damage caused by explosions, blasts and fires.
The Resolution aims to “regulate” the distributors behaviour on important activities related to safety aspects as well as to “monitor” the application and the process of the management in operating cathodic protection on steel pipelines in the distribution network.
In this scope the Resolution obliges the distributor to record a series of readings and information regarding cathodic protection of the steel network and communicate them to the Authority, as well as preparing an “Annual report on the electrical state of the distribution network”.
As regards the information to be supplied to the Authority it should be remembered that Resolution 168/04 specifies the need to only communicate the number of measurements of potential that conform to the applicable technical standards, without prejudice to the obligation for the distributor that for each potential measurement show the result of the evaluation of the readings on the “measurement report”, demonstrating whether these results conform or not to current applicable technical standards.

As regards the completion of the “Annual report on the electrical state of the distribution network”, the Resolution established that APCE must define a method permitting the demonstration that a distribution network has an adequate cathodic protection in accordance to what required by the applicable technical standards.

3. THE STANDARDS

Chapter V of Resolution 168/04 refers to technical standards for safety and continuity of operation while Paragraph 29.1 states that for the implementation of the Unified Code, the technical standards, technical specifications or the applicable UNI and CEI technical reports are applicable. Paragraph 29.2 states that should technical standards, technical specifications or applicable technical reports be lacking, the guidelines defined by the competent technical authorities ATIG (Associazione Tecnica Italiana del Gas, “Italian Gas Technical Association”) and APCE, published by the UNI, must be used.
The next paragraph obliges the distributor to respect the standards, the specifications and the technical reports as well as the guidelines contained in previous paragraphs, with particular emphasis on the completion of reports required for each measurement or intervention performed.
Gas distribution plants are also subject to fire-prevention inspections in accordance with Presidential Decree No. 37 dated Jan. 12th 1998; an article of this decree obliges the distributors to maintain efficient systems, devices and equipment and to perform regular inspections and maintenance. The obligation for a correct network operation and maintenance also includes cathodic protection while UNI standards require specific methods aimed to respect that obligation.
The technical standards issued by the UNI, or adopted from European standards (CEN, CENELEC), fix the design and construction of gas transport systems using urban networks, also referring to current legislation and clearly regarding to the application of cathodic protection to steel networks.
On this topic, UNI issued a series of technical standards which constitute the basis in the sector of cathodic protection of buried metallic structures, also covering steel gas distribution networks.
Complying with these standards (rules of good technique) during the design, construction and their implementation with a correct operation and maintenance of cathodic protection systems for steel networks ensure a high level of efficiency and reliability of these structures.
A correct operation and maintenance of cathodic protection in buried steel pipelines reduces to a minimum or completely cancels corrosion phenomena and at same time ensures the safety of people and properties derived by gas leaks into the ground and on the environment.
The main standards one must refer for the operation and maintenance of cathodic protection systems are UNI EN 12954:2002, UNI 11094:2004, UNI EN 13509:2004 and UNI 10950:2001.

4. THE GUIDELINES

Thanks to its historic role, APCE was recognised by the Authority as a competent technical organisation and was involved in defining guidelines in the field of cathodic protection of buried steel pipelines. This renewed official appointment was a further incentive to prepare the guidelines supporting applicable standards that, being the

official reference, must facilitate the understanding of the Resolution and guarantee a more uniform and coherent nationwide application by gas distributors.
The APCE guidelines can be defined as basic guidelines derived from technical and regulatory knowledge implemented with the experiences in gas distribution from experts of industry and universities , with the aim of supplying the most appropriate rules and instructions for the design, operation and maintenance of cathodic protection systems in gas distribution networks.
The guidelines were also written up to help even less experienced gas distribution companies in managing and running their plants at the best technical level aligning as much as possible the behaviour of different Companies.
The guidelines also have the function of spreading knowledge and supplying technical details to support decisions, to reduce the qualitative difference existing among different distributors and to facilitate the monitoring and evaluation of the activities performed.

4.1 The guidelines regarding the rules for cathodic protection

In January 2004, four years after the publication of the first version, UNI published the second edition of the APCE “Guidelines on cathodic protection of steel gas distribution networks” with updated regulatory references to make technical aspects established by UNI standards more explicit and to allow an univocal interpretation and similar behaviour by all distributors.
APCE guidelines supply common rules regarding the implementation, measurement, audit and inspection of the cathodic protection in steel gas distribution networks and define the criteria of conformity and acceptability of the measurements and the inspections performed.
The main novelty refers to the functional organisation of cathodic protection activity, human resources, the cathodic protection manager, the inspection programme and the maintenance manual.
The document also specifies the number of characteristic points to be identified in cathodic protection systems to evaluate their actual performance. Such a number depends on the level of variation of the electric field and the type of operation of cathodic protection system, i.e. whether the measurements are performed in a continuous way, with a remote-control system transmitting data to a verification and calculation unit, or in a discontinuous one, with periodical survey made on-site using indicating and/or recording tools.
The guidelines lend also great importance to the analysis of the measured potential values and specify in detail the criteria of validity and conformity of measurements made, both continuous and discontinuous, specifying the duration and total acceptable daily time needed to consider these measurements as conforming to the specifications.

4.2 The guidelines for the measurement of the level of reliability of cathodic protection

After the Guidelines, AEEG committed APCE the preparation of a mathematical model able to measure how all processes as regards the design, operation and maintenance of the cathodic protection systems comply with the requirements contained in the national and international standards and, in addition, in the APCE guidelines, using a numerical index K_T, *“the cathodic protection indicator”.*

It is very important to point out again that the model does not directly measure the level of effectiveness of cathodic protection applied to the pipelines i.e. how the actual potential values at the measurement points comply with the criteria of protection potential; in fact these evaluations and correlations are under the distributor's responsibility.

The model had to:

- represent activities technical conformity
- refer to the elements to be analysed only
- have logical significance
- be repeatable over time
- be sustainable in terms of data collection and resources used
- communicate information.

This was possible by defining the model, based upon the compulsory criteria of design, operation and maintenance of UNI standards shown in point 3, as well as other applicable rules.
The guideline project was prepared by a working-group composed by representatives of small, medium and large distributors, experts, service companies and category associations. In January 2005 it was submitted for public consultation in particular to share the consensus on this innovative approach and on critical definitions such as: "*conditions of efficient and non-efficient application of cathodic protection to the pipelines"* or "*steel network without cathodic protection*".
In May 2005 the UNI published the first edition of the APCE guidelines "Methods for the evaluation of the efficiency of cathodic protection systems in a gas distribution network".

The indicator K_T, which must be annually calculated for every cathodic protection system, is measured on a basis of 100 points of which 30 points are given to the design and the remaining 70 points are given to the management and running of the system
A cathodic protection indicator value $K_T < 60$ shows a non-efficient application of cathodic protection on the pipelines, while $K_T \geq 60$ shows an efficient application.
If K_T is lower than 60 intervention and measures are required on the CP system in order to improve the quality level.
Indicator values between 60 and 80 correspond to situations where the efficiency and reliability of the cathodic protection is ensured at a standard level. The range of twenty points allows for different operating conditions in which the cathodic protection must perform (electrical field, environment, state and level of conservation of the pipelines, etc.).
Values higher than 80 correspond to situations of a particularly careful and precise operation by the distributor or where the audits and inspections have been increased due to the size and variability of the interfering electric field.
All parameters influencing a cathodic protection system are transformed in numerical terms and the suggested formula for the cathodic protection indicator K_T is as follows:

$$K_T = \left(K_1 \cdot \sqrt{\frac{K_2}{70}} + K_2 \right)$$

Where K_1 takes into account the design aspects of the cathodic protection, in particular network length (in km) and the number of measurement stations associated with the cathodic protection system, while K_2 takes into account the aspects related to the cathodic protection system operation and maintenance and reflects its efficiency and reliability; K_2 can vary with kind of control system, i.e. whether the measurements are taken in field or by remote-control systems, from the number of measurements per year (both short-term and long-term measurements).

4.3 The guidelines in the annual cathodic protection report

In October 2005 UNI published the first edition of the APCE "Guidelines on preparation of the annual report regarding electrical state of cathodic protection of gas distribution network", outlining the common rules regarding the presentation methods of the general evaluation and describe how the data and information included on the special form must be shown

The annual report must give evidence of the calculation results of the cathodic protection indicator and of remedial actions, i.e. of the actions taken to increase this value, in particular when K_T is lower than 60.

The annual report regarding electrical state comprises five sections; for each section there is a description of data and information considered useful to keep under control over time the efficiency and reliability and a description of what has been implemented and performed in each system.

The first section covers data and general information regarding the gas distribution plant, the cathodic protection systems and the percentage of steel network protected and for which the parameters and relative formula are detailed.

Two sections are dedicated respectively to possible measures undertaken on the steel network not equipped with cathodic protection in the year; the report is prepared and the information that proves the reliability of operation of pipeline stretches protected with galvanic anodes.

The last two sections refer to impressed current cathodic protection systems whose cathodic protection indicator value, calculated for each system, shows the conditions of an efficient application on pipelines ($K_T \geq 60$) and of non-efficient application of cathodic protection ($K_T < 60$).

In both sections it is important to show the value of calculated cathodic protection indicator K_T which must correspond to the value shown in the relative certification.

In the event of non-efficient application of cathodic protection, the distributor must detail the ascertained reasons or possible anomalies, chosen from a list of specific indications, as well as the scheduled date of application of remedial actions

For cathodic protection systems with an indicator value (K_T) below 60, the guidelines show the criteria to define the admissible period within which the cathodic protection system must be restored to efficient application conditions.

In the following paragraphs, the guidelines show an example of the annual report on the electrical state and the forms showing the calculated value of the cathodic protection indicator K_T.

The annual report on cathodic protection electrical state of distribution network must be signed by the cathodic protection manager and kept available in the distributor offices together with the forms certifying the value of the cathodic protection indicator K_T for each cathodic protection system and measurement report.

The signature of the cathodic protection manager is of paramount importance since faced by the findings emerged from various audits and is the only person that can authorise necessary actions to be performed and guarantee their correct execution.

5. REFERENCES

1. AEEG Resolution nr. 168/04 “Unified Code of Authority for Electricity and Gas’s Provisions Concerning Quality of Natural Gas Distribution, Metering and Supply Services”.
2. UNI EN 12954 - Cathodic protection of buried or immersed metallic structures. General principles and application for pipelines.
3. UNI 11094 - Cathodic protection of buried metallic structures - General criteria for the accomplishment, inspection and survey, in presence of stray currents.
4. UNI EN 13509 - Cathodic protection measurement techniques
5. UNI 10950 - Cathodic protection of buried metallic structures - Remote control of cathodic protection systems.
6. UNI-APCE - “Guidelines on cathodic protection of steel gas distribution networks”
7. UNI-APCE - “Methods for the evaluation of the efficiency of cathodic protection systems in a gas distribution network”
8. UNI-APCE - “Guidelines on preparation of the annual report regarding electrical state of cathodic protection of gas distribution network”.