CORROSION ENGINEERING SOLUTIONS

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# MONITORING OF CATHODIC PROTECTION SYSTEMS FOR REINFORCED CONCRETE & HISTORIC BUILDINGS

## Introduction

The published Code of Practice – BS EN ISO 12696:2016 Cathodic Protection of Steel in Concrete describes the requirements for assessing the performance of Cathodic Protection systems; and BS EN ISO 15257:2017 states what level of expertise is required for the different tasks within this field of engineering. Although this guidance is useful it can be confusing and, as with any standard, cannot account for individual circumstances.

The aim of this briefing note is to simplify the available information into a single document designed to give those who are responsible for buildings and civil engineering structures [which have been treated with cathodic protection] an overview of what should be done, when and by whom. If the owner is outsourcing these activities, this document gives an overview of what to expect from their suppliers.

## The Monitoring Regime

Although the monitoring regime stated in BS EN ISO 12696 [and outlined below] is generally the basis of any monitoring regime, the first point of call when determining what should be done [and how frequently] should be the design documents and any subsequent monitoring reports.

Just because the published guidance says that something must be done, or done in a certain way, it is not mandatory. What *is* required is for the design engineer to fully justify any deviation from the guidance. Simply stating that a single inspection once every five years will suffice, is unlikely to stand up to scrutiny and will almost certainly be inadequate from a technical point of view. It is quite normal for a design or monitoring engineer to adjust the assessment intervals depending on the nature of the structure, its' criticality, the risk of damage and the length of time it has been protected for.

As discussed below, an absence of a remote connection to a system can make frequent checking prohibitively expensive. Similarly, galvanic systems [depending on their design] often require less frequent assessment. Owners should note that the published guidance advises that some systems require *less* monitoring, not *no* monitoring. All CP systems regardless of their nature require some degree of monitoring and assessment. CP is not a “fit and forget” technology.

As stated above, however, any deviation needs to be fully justified with reference to the standards. Reducing the monitoring and testing frequency/capability simply because it is commercially advantageous to do so is likely to be negligent legally and is certainly bad engineering.

## A Typical Regime

Most Cathodic Protection systems that are applied to reinforced concrete structures, or masonry-clad buildings will require the following monitoring, adjustment and reporting regime, unless it can be justified otherwise.


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## Function Checks

At intervals not exceeding one calendar month, someone should check that the system is operational, that it has power and the outputs are similar to those of the most recent assessment. If the system has remote connection facilities, this can be done reasonably quickly by the monitoring engineer/technician and the time required is proportional to the size of the system [and the reliability of the remote connection]. An example of a modern system is shown in Figure 1.

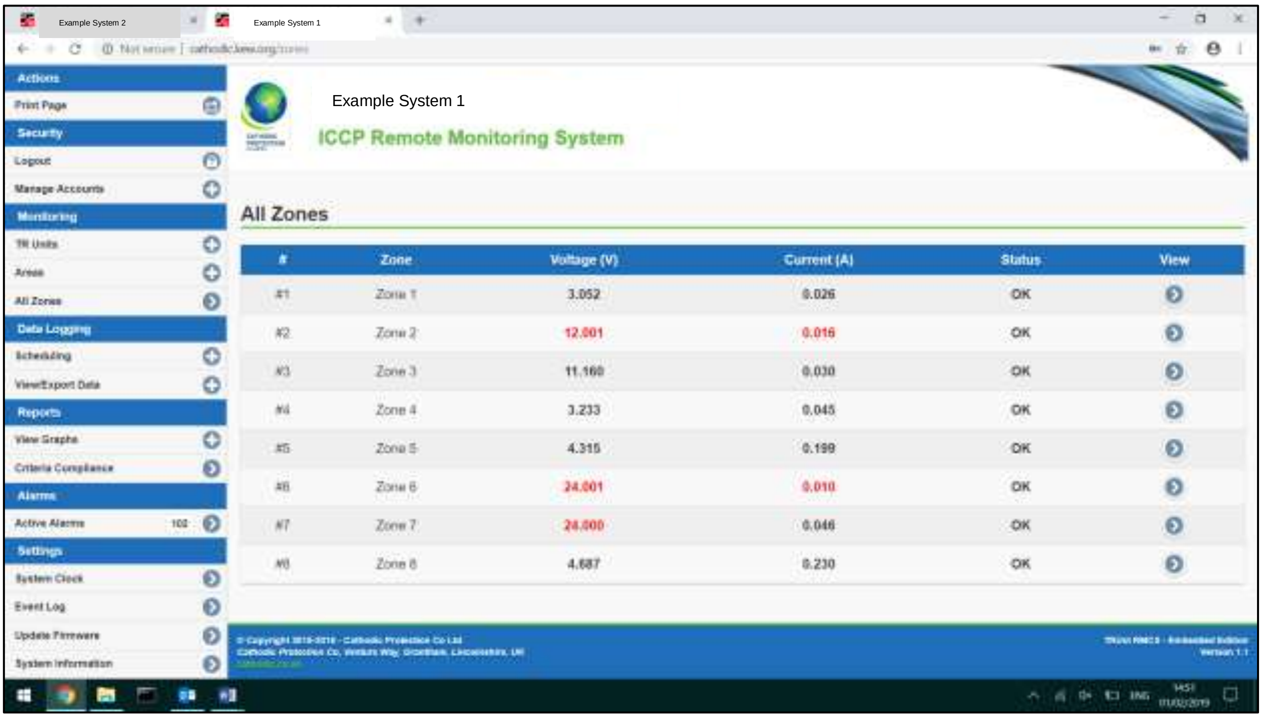


*Figure 1 - Example of Remote Control Screen*

With a modern set of control equipment and a reliable remote connection, the outputs for each zone can be quickly noted and compared to the last adjustment.

If the system does not have a remote connection facility, it is usual for the monitoring engineer to delegate this to someone who is on site frequently and can carry out a quick visual check [reporting back to the monitoring engineer over the phone if necessary].

## Quarterly Performance Assessment

Sometimes referred to as "*Quarterlies*". This is the process whereby a qualified individual assesses the performance of the system and makes any adjustments to the settings as necessary. As the name implies, this should be carried out at intervals not exceeding three months.

The engineer/technician's ability to interrogate the system or data will depend on nature of the control equipment and type of CP or components embedded into the structure. Generally, a depolarisation test is required for each zone and


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the results should be analysed and a judgement on the level of protection made. The output of a typical depolarisation test, and its analysis, is shown in Figure 2.

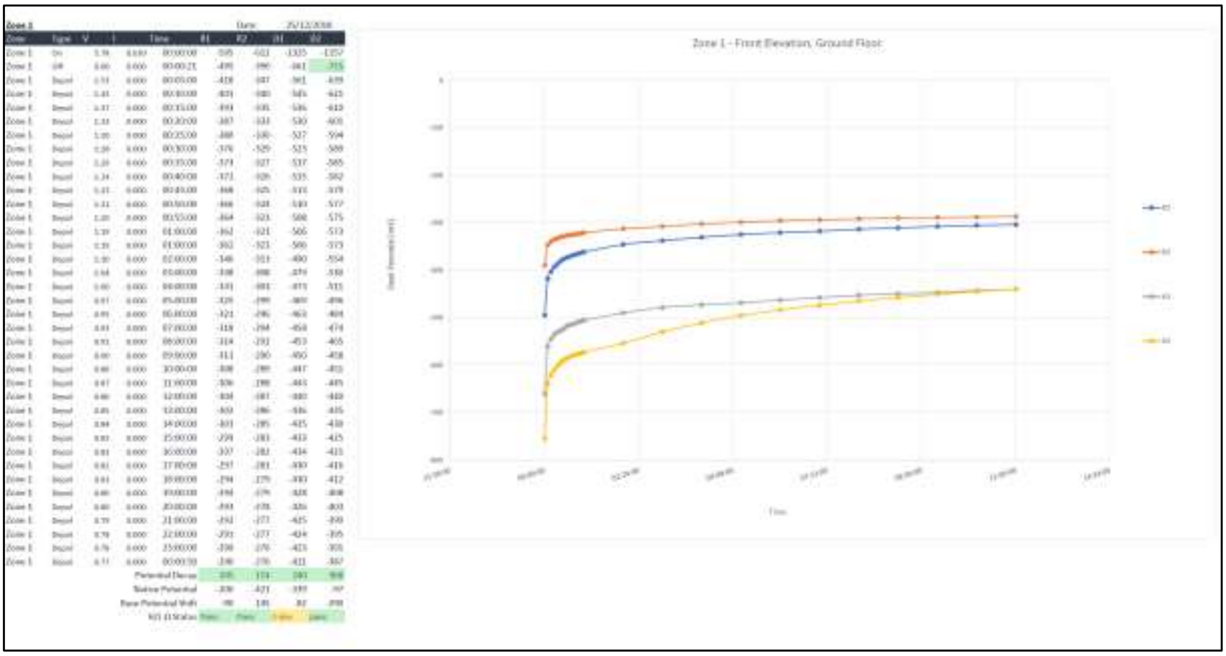

*Figure 2 - Example of a Depolarisation Test Analysis*

## Annual Inspection

At intervals not exceeding 12 months the protected structure [or elements of the structure] should be visually inspected to ensure that remote monitoring data is an accurate representation of the corrosion condition. Evidence of re-current cracking to concrete/masonry, spalling or displacement, acidification of the anode; should be recorded.

At this time, the Cathodic Protection components should be inspected for damage and/or degradation. Typically, this involves inspecting the electrical enclosures to ensure the seals are sound and determine if the components are in need of repair/maintenance. It is also good practice for the engineer to compare the actual outputs/values measured at the terminals, with those recorded by the software. Discrepancies of this sort are less frequent as digital technology improves, but failures can still lead to data suggesting all is well when it is not [or vice versa].

## Annual performance report

For each 12 month period a detailed performance report should be produced documenting the level of protection provided and recommendations for any repair or maintenance that may be required. This document serves to inform the owner of the structure but also allow them to plan ahead for any capital spending, investigation or repair that may be required. A usual feature of these reports is a warning to the client of how many years are left until significant maintenance [replacement of monitoring sensors, control equipment or sacrificial anodes]. The report should also contain [or contain a reference to] a reasonably complete set of monitoring data.

In many cases the monitoring reports are a requirement of the life time records. There are cases where monitoring records have been sought as part of due diligence during sale and acquisition, and the sale has been impeded by incomplete, or inadequate records. Similarly, problems can be encountered during principal inspection of bridges, or where a heritage building has been diagnosed with Regent Street Disease but there is not a complete record of the protection.

## Qualifications

Competence and qualification criteria for engineers and technicians operating CP systems have been independently established in the form of BS EN ISO 15257:2017. In the UK the certification scheme is operated by the Institute of Corrosion [ICorr].

In most cases monthly function checks can be undertaken by a Level 2 [formerly Level1 prior to 2017] technician or an unqualified person under direct supervision/direction of a Level 3 [formerly L2] or higher. As discussed above, it is common for a member of the building or bridge's maintenance staff to carry out function checks if there is no remote connection facility. Engaging a qualified person to visit site once a month for this activity is usually an unjustifiably expense.

Other monitoring tasks can be performed by someone certified to Level 3 [formerly L2] or higher. This includes the quarterly performance assessments, visual inspection and reporting. The exceptions to this are when the structure or system is considered complex.

Any structure or system that is unusual will require the expertise of a Level 4 [formerly L3] engineer to assess the performance. Common situations include:

- reinforced concrete structures in tidal environments,
- pre-stressed steel,
- historic steel-framed masonry-clad buildings,
- structures in low oxygen environments,
- or where the structure/system is subject to interference.

In these circumstances the performance data often require detailed assessment, often in reference to similar structures, and this is outside of Level 3 competence. There are many circumstances where a too basic interpretation of performance data can lead to the owner being told that the system is not providing protection and expensive investigations repairs are needed when, in reality, the level of protection is adequate. Conversely there are features of certain systems/structures where erroneous data or inappropriate settings can lead to data suggesting protection is being provided when, in fact, it is not.

Finally, the monitoring regime should be determined by the designer who should be certified to Level 4 [formerly L3]. An over-zealous regime is likely to result in excessive and unnecessary costs, whereas an inadequate regime can lead to faults being identified too late to take action, damage to the system, or the value of the protected asset being affected.