

# Stray Current Calculation and Monitoring in DC Mass-Transit Systems

## Interpreting Calculations for Real-Life Conditions and Determining Appropriate Safety Margins

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This article delivers useful practical contemplation of stray current calculation and monitoring endeavors in dc mass-transit systems. We focus on interpreting stray current calculations—carried out at the design stage for real-life conditions—and on determining safety margins to cope with calculations following oversimplifying assumptions. We also discuss the general specifications and benefits of the direct stray current monitoring method, through addressing the implications that arise from implementing the alternative rail potential monitoring method informatively quoted in European (EN) Standards.

### Introduction

Over the past few decades, the stray current modeling and monitoring endeavors in dc mass-transit systems can be broadly summarized as follows:

- Existing railway stray current model applications have the ability to compute rail voltage to remote earth and current flow [1], [2] in the modeled components under various scenarios, depending on their design and level of complexity [3], [4].

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- Assessments of the corrosion impacts are made as qualitative assessments using a mix of engineering judgment and simple spreadsheet applications of Faraday's laws to assess the cumulative mass of metal loss over the target operating period [5].
- Application of Faraday's law requires consideration of current flows, whereas the most common site of validation measurement is corrosion potentials in railway system structures and utility assets to a local reference [6], [7].
- Railway stray current flows are time-variable in response to timetabled train operations and bidirectional as a function of dynamic changes in multiple train positions and train regeneration characteristics [8], [9].
- The impacts measured on affected structures and services present the net effect from these variable factors.
- Current impact assessment techniques are limited to simple time averaging and linear extrapolation of current flows from either static or dynamic model outputs [10].
- By contrast, current standards (e.g., EN 50122-2 [11] and EN 50162 [12]) apply criteria based on exceedance of absolute or averaged corrosion potential thresholds without regard to current flows.

In particular, EN 50122-2 specifies requirements for protective provisions against the effects of stray currents, which result from the operation of dc traction systems. This applies to all metallic fixed installations, which form part of the traction system, and also to any other metallic components located in any position in the earth, which can carry stray currents, resulting from the operation of the railway system. To this end, EN 50162:2004 completes EN 50122-2 by establishing the general principles to be adopted for minimizing the effects of dc stray current corrosion on buried or immersed metal structures.

### Stray Current Calculations

#### Interpreting Stray Current Magnitude

Stray current magnitude depends on the traction current, the rail resistance, and the resistance to the earth value. Applying the equation in the EN 51022-2:2010 Annex C to a data set with a maximum expected traction current of 2,000 A that is equally returning through a 500-m section of two rails (i.e., 1,000 A on each side) with a resistance of 40 mW/km of rail and a resistance to earth of 100 W/km results in a  $I_{\text{stray}}$  of 50 mA.

However, care should be taken when