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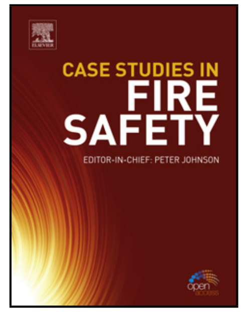

Title: Bi-modal trending for corrosion loss of steels buried in soils

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Bi-modal trending for corrosion loss of steels buried in soils

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Highlights for paper “Bi-modal trending for corrosion loss of steels buried in soils”

- For exposures up to 15-17 years of steels buried in a variety of soils the progression of corrosion loss shows bi-modal trending for almost all soils.
- It is proposed that for the remaining cases the trends in the data can be interpreted as not yet having fully developed the bi-modal trend within the 15-17 year exposure period.
- A bi-modal trending representation also is appropriate for maximum pit depth.

Abstract
Corrosion loss data from the 1957 NBS study for steels buried in a large variety of soils and exposed over 12-17 years are re-interpreted, supported with estimates for scatter in the data. This shows that losses predominantly are consistent with the bi-modal trending pattern also previously observed for steel exposed in a variety of other environments. For short-term and low time of wetness exposures the trends are consistent with mode 1 of the bi-modal trend. These reinterpretations should permit development of better understanding of the factors important for short- and-long term corrosion trends and for improved modelling and prediction.

Keywords: Steel; Soils; Mass loss; Modelling; Long-term; Trends; Data scatter.

1. Introduction
The long-term progression of corrosion of steels buried in soils remains a matter of considerable practical interest, especially where cathodic protection has not been applied, or protective coatings have deteriorated. This often is the case for older infrastructure. Examples include gas, water and oil pipelines, communication, signal and power cable systems and underground water and fuel tanks [1]. For adequate predictions for engineering and for infrastructure applications it is highly desirable to be able to make quantitative predictions of likely future corrosion losses under given conditions. Ideally this is achieved with a mathematical model to allow rational extrapolation from given observations and conditions. Typically such a model consists of a trend for the mean (or expected) value of corrosion loss as a function of time [2, 3]. It also may consider statistical uncertainty, including that arising from the variability or scatter in corrosion losses and pit depths that inevitably occurs between individual observations in practical (particularly field) experimental conditions [4].

For most engineering and infrastructure applications a model for representing corrosion loss (or pit depth) as a function of exposure period need not be a perfect representation of all aspects of the corrosion process. However, it must have sufficient theoretical and empirical validity to capture the essential trend in corrosion loss (or pit depth) [3]. Such a model also should be consistent with trends for steel corrosion in related exposure environments. In this context, Tomashov [5] noted that the corrosion of steels in soils should have similarities with the corrosion of steels in atmospheric exposure conditions. This implies directly that it should involve the concept of time of wetness (TOW), that is, the period of time during which the metal surface is sufficiently wet for corrosion to be possible, assuming sufficient availability of oxygen [6].

The corrosion of steels in the atmosphere has long been associated with the power law, including for long-term exposures [6]. However, recent work has shown that much of the atmospheric corrosion loss data for