The Relevance of the NOAEL concept and related parameters in defining pollution thresholds for cultural heritage collections.

Jens Glastrup
The National Museum of Denmark
Dept. of conservation
Brede, post box 260
DK 2800 Kgs. Lyngby
Denmark
e-mail: jens.Glastrup@natmus.dk

In recent articles[1,2], Tétreault and colleagues have published results which indicate that the oxidation/corrosion of lead surfaces in acetic acid occur primarily at concentrations above 300 µg/m^3.
However, the results are primarily based on experiments in which the materials of interest (thin plates of lead) with dimensions of 2 x 5cm, are placed in a potentially corrosive atmosphere. These plates are weighed periodically on a balance with a precision of 0.1mg, and one of the crucial parameters is a measurable weight gain of these plates.
The uncertainty and limit of measurable differences in weight gain on the plates can therefore safely be assessed as 0.1mg, but will often lie in the range of 0.2-0.5mg, depending on the location of the balance and parameters, including, RH, temperature, stability of the floor etc. If we assume that the average density of the corrosion layer is 5g/cm^3, the average corrosion layer thickness on the 2 x 5cm plate must be at least 10nm before it can be acknowledged that there is a significant difference in the weight of the plates, and typically this layer will be in the range of 20-50nm. The length of the experiments are 135days, and it is therefore safe to deduce that an increase in the corrosion layer of at least 25nm/year – and more likely between 50 to 125nm/year – will remain unnoticed based on the present experimental design.
Tétreault partly defines the "NOAEL (No Observable Adverse Effect Level)" from the above-mentioned parameters. The parameter itself is defined as: "the highest level of a pollutant that does not produce an adverse effect on a specific chemical or physical characteristic of a material in a particular experimental set-up. The parameter is difficult to discuss because of the inherent limitation: "*in a particular experimental set-up*" and its use should therefore ideally be limited to discussion in connection to a specific round of experiments. This can clearly be illustrated by a thought experiment where the balance used for the experiment has a 1mg limit. Here the NOAEL limit would equal a minimum annual corrosion layer thickness of 250nm, or for a balance with a 0.01mg limit an annual corrosion layer thickness of 2.5nm.
Nevertheless, the parameter is now spreading in the conservation literature as a given standard, see e.g. Hatchfield[3] or Tétreault[4], and it is my fear that standards for concentrations of especially formic and acetic acids are being set in museums or galleries based on experiments that basically cannot detect an annual corrosion layer increase of 25nm.
My question is therefore also: do we dare to rely on a NOAEL parameter that is dependent on experimental design, and in which those experiments have a detection limit of minimum 25nm/year?

Reference List

1. Tétreault,J., Sirois,J. & Stamatopoulou,E. Studies of lead corrosion in acetic acid environments. *Studies in Conservation* **43**, 17-32 (1998).

2. Tétreault,J. *et al.* Corrosion of Copper and Lead by Formaldehyde, Formic and Acetic Acid Vapours. *Studies in Conservation* **48**, 237-250 (2003).

3. Hatchfield,P. Pollutants in the Museum Environment. Archetype Publications Ltd., London (2002).

4. Tétreault,J. Airborne Pollutants in Museums, Galleries, and Archives: Risk Assessment, Control Strategies, and Preservation Management. Canadian Conservation Institute, Ottawa (2004).