IAQ 2006

Indoor air quality standards for cultural heritage?

Simon Watts
School of Life Sciences,
Oxford Brookes University,
Headington, Oxford, UK
OX3 0BP
sfwatts@brookes.ac.uk

Indoor air quality Standards for cultural heritage?

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- What is a standard ?
- Air quality standards for health
- Indoor air quality standards for health

- The nature of Indoor air quality standards for cultural heritage

- The artefact management plan

- The approaches

- Where to go

- Apologies and thank-you

What is a standard?

1. A flag, banner, or ensign, especially: **a.** The ensign of a chief of state, nation, or city.**b.** A long, tapering flag bearing heraldic devices distinctive of a person or corporation.**c.** An emblem or flag of an army, raised on a pole to indicate the rallying point in battle.**d.** The colours of a mounted or motorized military unit.**2. a.** An acknowledged measure of comparison for quantitative or qualitative value; a criterion.**b.** An object that under specified conditions defines, represents, or records the magnitude of a unit.**3.** The set proportion by weight of gold or silver to alloy metal prescribed for use in coinage.**4.** The commodity or commodities used to back a monetary system.**5.** Something, such as a practice or a product, that is widely recognized or employed, especially because of its excellence.**6. a.** A degree or level of requirement, excellence, or attainment.**b.** A requirement of moral conduct. Often used in the plural.**7.** *Chiefly British* A grade level in elementary schools.**8.** A pedestal, stand, or base.**9.** *Botany* **a.** The large upper petal of the flower of a pea or related plant.**b.** One of the narrow upright petals of an iris. Also called *banner*, *vexillum*.**10.** A shrub or small tree that through grafting or training has a single stem of limited height with a crown of leaves and flowers at its apex.**11.** *Music* A composition that is continually used in repertoires.*adj.* **1.** Serving as or conforming to a standard of measurement or value.**2.** Widely recognized or employed as a model of authority or excellence: *a standard reference work*.**3.** Acceptable but of less than top quality: *a standard grade of beef*.**4.** Normal, familiar, or usual: *the standard excuse*.**5.** Commonly used or supplied: *standard car equipment*.**6.** *Linguistics* Conforming to established educated usage in speech or writing.[Middle English, from Old French estandard, *rallying place*, probably from Frankish *standhard : *standan, *to stand*; see st - in Indo-European roots + *hard, *fast, hard*; see kar- in Indo-European roots.]

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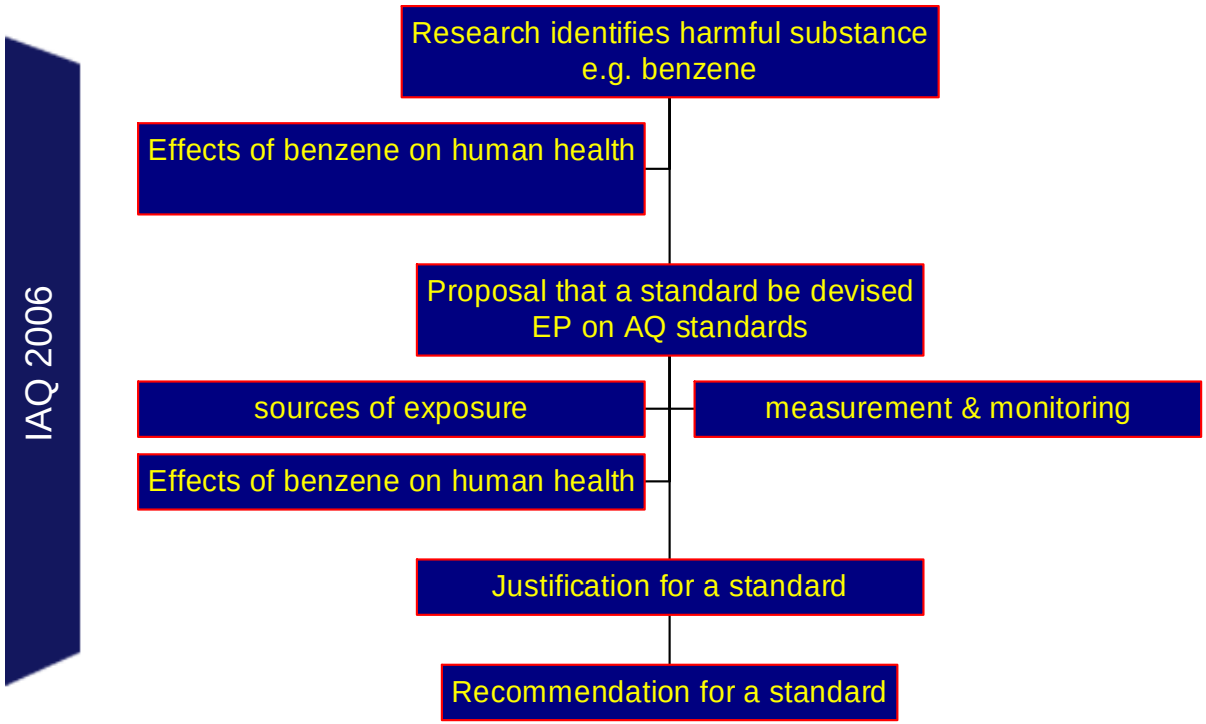
Air quality standards for health

Process of setting an AQ standard



- Benzene is a carcinogen which is emitted from internal combustion engines
- Considerations that influence the particular value of a standard
  - economics
  - realities
  - safety
  - exposure
  - synergistic effects

Benzene All Authorities	16.25 µg/m^3	Running Annual Mean	31 December 2003
Benzene Authorities in England and Wales only	5 µg/m^3	Annual Mean	31 December 2010
Benzene Authorities in Scotland and Northern Ireland only[a]	3.25 µg/m^3	Running Annual Mean	31 December 2010

Indoor air quality standards for health

- Covered by Yoshika. Issues that determine (in this case) the IAQ standards for formaldehyde include
  - Effects of formaldehyde on human health
  - People in the developed world spend 70 - 80% of their time in buildings
  - Average age of housing stock in Japan, (consequence of building materials), (consequence of environmental conditions)……
- NB example where indoor dose is greater than outdoor dose - Ozone example:
  - Reading UK 48 (2-180) μgm^{-3}, I/O ratios 0.40* 60% O_3 dose Indoor
- Interesting philosophical and operational questions about indoor health standards

(*) Poupard et al (2005) Indoor Air 15 pp2-12.

The nature of Indoor air quality standards for cultural heritage

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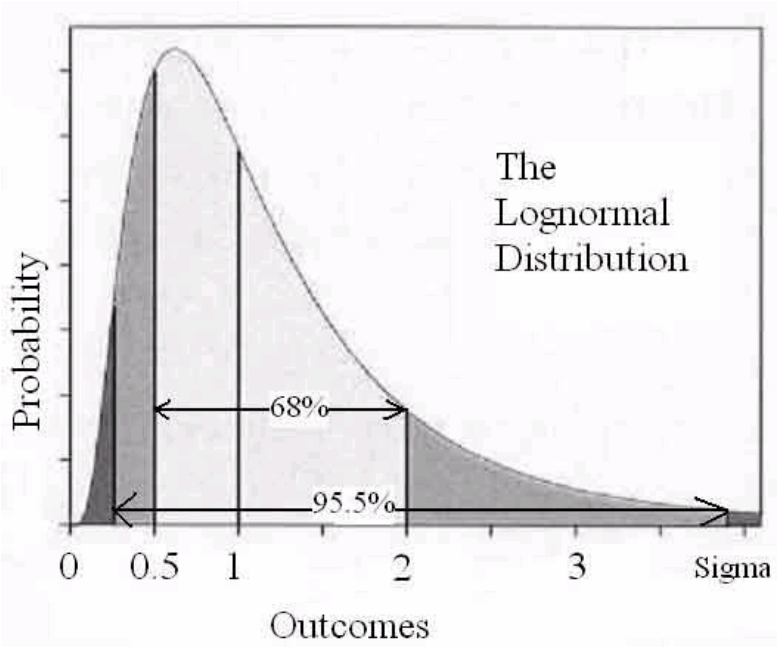
Tube	Site	Wha	Sple	B	C	C	Time /	[H2S]	unit	Deployment Dates		C	COMMENTS
6/10/05/H2S/13	Photomuseum Arch	H2S	122				1008	78	ppt	14-Oct-05	25-Nov-05		error ±16
6/10/05/H2S/14	Photomuseum Outc	H2S	134				1008	43	ppt	14-Oct-05	25-Nov-05		error ±12
6/10/05/H2S/15	Photomuseum Arch	H2S	142				1008	28	ppt	25-Nov-05	6-Jan-06	DL	error ±12
6/10/05/H2S/16	Photomuseum Outc	H2S	147				1008	19	ppt	25-Nov-05	6-Jan-06	FDL	error ±6
17/10/05/OCS/17	Photomuseum Arch	OCS	###				1008	562	ppt	14-Oct-05	25-Nov-05		error ±89
17/10/05/OCS/18	Photomuseum Outc	OCS	###				1008	540	ppt	14-Oct-05	25-Nov-05		error ±85
17/10/05/OCS/19	Photomuseum Arch	OCS	###				1008	593	ppt	25-Nov-05	6-Jan-06		error ±73
17/10/05/OCS/20	Photomuseum Outc	OCS	###				1008	496	ppt	25-Nov-05	6-Jan-06	C	error ±175

- Taking reduced sulfur gases and silver as an example
  - What do conservators need ?
  - What does 78 ± 16 ppt H_2S mean ?
    - Geography and context

Individual artefacts

- People react differently to the same dose of a drug, the attack of a virus…*etc*
- Artefacts react differently to pollutants in terms of their reactivity, however, this affects (only) the kinetics of damage.
- Poisons with no threshold act rather like pollutants with artefacts. It is the cumulative **dose** of radiation that killed the Curies, similarly the total dose of pollutant will tarnish and eventually destroy a silver artefact



The Conservation Management Plan

- So we get down to individual artefacts

- Whatever “standard” is adopted, needs to:
  - hold for conservation management plans from 1 year to >100 years…which means immediately that the “standard” will have to be zero ppt (cumulative dose)
  - account for the visiting public

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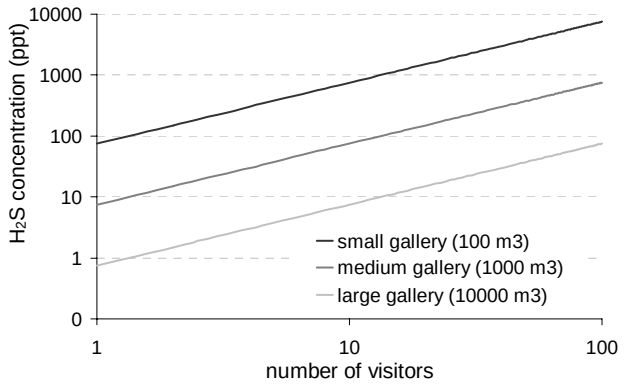
Ankersmit, H. Tennent , N, Watts, S.F. [2005] Atmos. Env. **39** pp695-707.

$$\Delta[H_2S]_{gallery} = \frac{[H_2S]_{breath} \cdot n_b \cdot V_b \cdot \Delta t \cdot n_v}{V_g}$$

$[H_2S]_{gallery}$ = H_2S gallery concentration (m.r.)
$[H_2S]_{breath}$ = H_2S breath concentration (150.10^{-9} m.r.)
n_b = amount of breaths (15 min^{-1})
V_b = volume of a typical breath (0,001 m^3)
Δt = time a person spends in a gallery (5 min)
n_v = number of visitors in the gallery
V_g = volume of the gallery (m^3)



Approaches

- Using health based standards – or typical clean outdoor levels as standards – concentration based.
- No Observable Adverse Effect Level NOAELs – concentration based
- Lowest Observable Adverse Effect Dose (LOAED) – really is about at what point it shows - for silver a tarnish layer of ~ 250 - 290Å becomes visible to most people
- Corresponds to an absolute amount of sulfur (per surface area) which has come from sulfur containing gases in the atmosphere – or an absolute CUMULATIVE DOSE. May have taken a few days or ten years.
- Some modern “museum standards” still exist, some based on management plans, some seem not to be..

Ankersmit, H. A., G. Noble, L. Ridge, D. Stirling, N. H. Tennent and S. F. Watts (2000). The protection of silver collections from tarnishing, tradition and innovation. Advances in conservation. Mellbourne, International Institute for Conservation: pp7-13

Tétreault, J. (2003). Airborne pollutants in museums, galleries and archives: risk assessment, control strategies and preservation management. Ottawa, Canadian conservation institute.

Using the LOAED method (reduced sulfur gases on silver)

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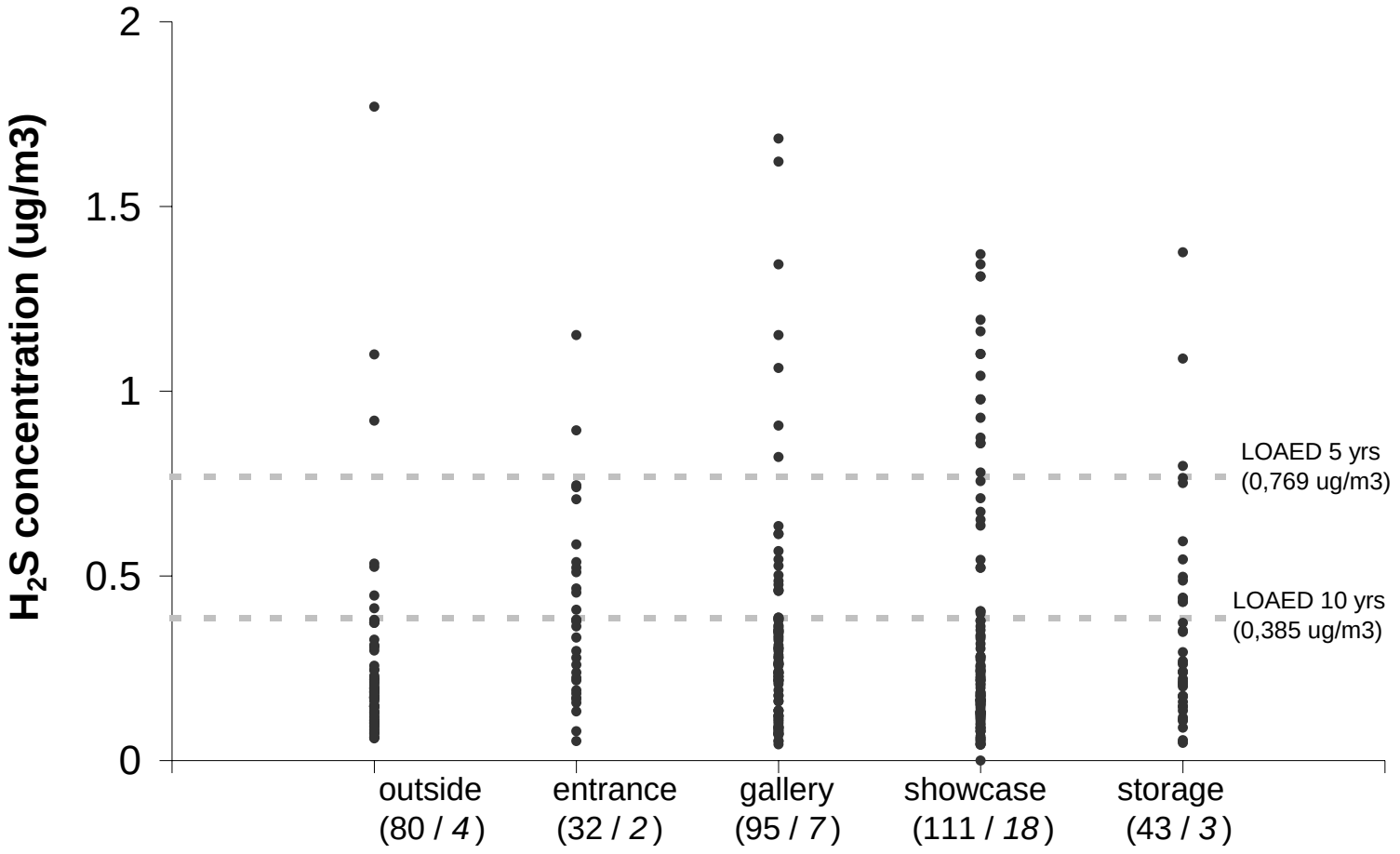

Research Approaches

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- Various EU projects under frameworks 4, 5 and 6 which have produced the underlying work to enable understanding of processes and measurement ability. Alongside these the national institutions have dealt with some of these issues from a national or organisational perspective…
- Classification of objects in terms of their response, risk assessment, the structure of a standard or set of standards (based on dose)
- COST Action D42
- EU Committee CEN TC 346/ WG 4 (Indoor Air Quality Standards)
- Potentially an ARC funded project complementary to COST D42
- Result of this funding is fundamental work is proceeding

Where to go?

- Critical doses calculated for artefacts
- According to a “one off” survey of pollutant levels and occasional checks
- As part of artefact management plans target concentration ranges chosen as local traffic light guidance – note synergistic effects (positive or negative), experience and risk management.
- Mitigation undertaken only when ambient building levels exceed management plan traffic light guidance
- Continuous monitoring unusual. Does not rule out specific work for particular areas of institutions.

Apologies and Thank-you

- Thank-you particularly to Bart Ankersmit and the SILPROT team for the work quoted in the silver example.

- Thank-you also to the various conservators and academics who have taken the time to discuss these issues directly with me.

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