

5. Summary and evaluation

TÜV NORD Umweltschutz GmbH & Co. KG examined a torso model made of plastic for 3B Scientific GmbH with regard to the emission of volatile, organic chemical substances.

5.1 Evaluation according to Appendix 6, JIS A 1901:2003

The results of the examination should be consulted for checking compliance with the standard values specified in **Appendix 6, JIS A 1901:2003** (translation from Japanese).

The following standard values for ambient air concentrations have been specified there.

Substance	Indoor concentration guideline*
Formaldehyde	100 µg/m ³ (0.08 ppm)
Toluene	260 µg/m ³ (0.07 ppm)
Xylene	870 µg/m ³ (0.20 ppm)
Paradichlorobenzene	240 µg/m ³ (0.04 ppm)
Ethylbenzene	3,800 µg/m ³ (0.88 ppm)
Styrene	220 µg/m ³ (0.05 ppm)
	1 µg/m ³ (0.07 ppb)
	0.1 µg/m ³ (0.007 ppb) for children
Chlorpyrifos	
Di-n-butyl phthalate	220 µg/m ³ (0.02 ppm)
Tetradecane	330 µg/m ³ (0.04 ppm)
Di-n-ethylhexyl phthalate	120 µg/m ³ (7.6 ppb)
Diazinon	0.29 µg/m ³ (0.02 ppb)
Acetaldehyde	48 µg/m ³ (0.03 ppm)
BPMC, Fenobucarb	33 µg/m ³ (3.8 ppb)
Total VOCs	400 µg/m ³

* Converted to values at 25 deg C;
1 ppb = 1/1,000 ppm

The following substances from this list are insecticides or herbicides.

These have not been examined here as these substances (after consultation with the manufacturer) are not used during manufacture of the products: paradichlorobenzene, chlorpyrifos, Diazinon and BPMC, fenobucarb.

The following has been established for the remaining substances in this list:

The standard values mentioned above have not been exceeded for any of the concentrations calculated for the model room both after 3 as well as after 28 days. The calculated concentrations were all significantly less than these standard values.

5.2 Evaluation according to ambient air standard values

The results of the examination should also be consulted for checking compliance with the published standard values for ambient air in Germany: Here a so-called Standard Value I (SV I) and a Standard Value II (SV II) are compiled for a range of individual substances.

Explanation of the terms Standard Values I and II:

Standard Value II (SV II) is an effects-related value which is based on the current toxicological and epidemiological knowledge of the effects threshold of a substance and the use of uncertainty factors. It shows the concentration of a substance which requires immediate action when reached or exceeded as this concentration is used to illustrate a health hazard, particularly for sensitive persons, for continuous presence in the rooms.

The need for action means a need for immediate inspection, e.g. with respect to decontamination decisions for reducing the exposure.

Standard Value I (SV I) is the concentration of a substance in the inside air where no adverse effects on health even for lifelong exposure according to the current state of knowledge are expected in the context of examination of a single substance. Exceeding this value is associated with an excessive hygienically undesired load. There is also a need for action for precautionary reasons in the concentration range between SV I and SV II. The SV I is derived from SV II by introducing an additional factor (usually 10). This factor is a convention.

The SV I can be used as a decontamination target value. It should not be "exploited", but instead should be less if possible.

The results can be evaluated as follows:

Toluene

The following standard values must be consulted for toluene in indoor areas: Standard Value I: 0.3 mg/m^3 ($300 \text{ }\mu\text{g/m}^3$) and Standard Value II: 3 mg/m^3 (Source: Federal health bulletin (Bundesgesundheitsblatt) November 1996, Number 11: Standard Values IRK/AGLMB).

Result for the **calculated** concentration in the model room:

In the present case this results in toluene concentrations of less than $1 \text{ }\mu\text{g/m}^3$: Standard Value II and Standard Value I are clearly complied with.

Total concentration of VOC (TVOC)

A so-called TVOC (Total Volatile Organic Compounds) Standard Value without toxicological justification for the total of the volatile substances from the solvents range (VOC) based on experience values has been derived by the Indoor Air Hygiene Commission of the Federal Department of the Environment:

- In rooms intended for long-term occupation, a total value (TVOC) in the range of 1 to 3 mg/m^3 (equivalent to 1,000 to $3,000 \text{ }\mu\text{g/m}^3$) should not be exceeded on a continuing basis.
From our own expert's report experience, it must be noted here that there can already be adverse effects on health in causal relationship with the air quality in individual cases in the concentration range mentioned.
- For long-term use a total value (TVOC) of 0.2 to 0.3 mg/m^3 (equivalent to 200 to $300 \text{ }\mu\text{g/m}^3$) applies as hygienic precautionary range.

Result for the **calculated** concentration in the model room

The present TVOC short-term values of $259 \text{ }\mu\text{g/m}^3$ (3d measurement) and $97 \text{ }\mu\text{g/m}^3$ (28d measurement) are clearly less than the range of 1000 – $3000 \text{ }\mu\text{g/m}^3$ considered tolerable by the

Indoor Air Hygiene Commission. The listed total value of 200 to 300 µg/m³ recommended for the hygienic precautionary range is also complied with.

Thereby it must be noted that the 300 µg/m³ value is in fact not exceeded after 3 days but is clearly utilized. This is significant insofar as there are always several potential emission sources (carpets, paint, furniture, etc.) according to experience in a typical indoor area. If a single source already basically exploits the Standard Value, exceeding the Standard Value overall is very likely by the addition of the emission effects.

However, the TVOC emissions of the torso model are clearly lower after 28 days which also significantly reduces the risk of exceeding the Standard Value by the addition of emission effects.

Carbonyl compounds

Formaldehyde

The former Bundesgesundheitsamt (BGA) (Federal Health Authority) recommends that a value of 0.1 ppm (120 µg/m³) of formaldehyde should be maintained in indoor areas.

Result for the **calculated** concentration in the model room:

In the present case, the concentration of less than 0.01 ppm in the ambient air was significantly less than the formaldehyde Standard Value.

Other carbonyl compounds

Preliminary Standard Values I for indoor areas (published by the Hamburg Science and Health Authority (BWG)) have been proposed for the following carbonyls.

Standard Values (SV I) for carbonyl compounds

Carbonyl compound	Concentration as concentration in µg/m ³
Propanal	20
Butanal	10
Hexanal	20
Furfural	20
Carbonyls total (C3-C6)	100

Result for the **calculated** concentration in the model room:

In the present case, the levels in the ambient air have been significantly less than the Standard Values.

Other single compounds

A variety of single compounds from the “solvents range” in the test chamber samples were proven to have low corresponding ambient air concentrations. Such concentrations are also to be expected in “uncharged” ambient air situations.

The concentrations of these single compounds were not above the official Standard Values of the Indoor Air Hygiene Commission of the Federal Environment Agency (or e.g. above the standard values of the BAGS / BUG in Hamburg).

5.3 Phenol

Among the VOC, phenols and cresols have a special significance with respect to a possible odor problem. Currently there is no indoor Standard Value for phenol. A test threshold of < 100 µg (units/h) has been proposed for phenol as an interim evaluation basis for emissions from electrical appliances.

(Wensing et al., Untersuchung von Emissionen aus Bürogeräten, Gefahrstoffe, Reinhaltung der Luft, 63 (2003) No. 3 March).

The level will not drop below this value after 3 days and probably also not after 28 days (for this sample, the phenol signal is overlaid, thus a distinct quantification from the screening sample is not possible).

5.4 CMT substances

Carcinogenic, mutagenic and teratogenic (reprotoxic) substances.

During the testing described above with respect to the calculated concentration in the model room, the following substances have not been detected:

1. Substances which are listed in Appendix I of the Directive 67/548/EEC and/or in the publication of the list of dangerous substances and preparations according to § 4a Section 1 in its respectively relevant version and/or which must be classified according to § 4a Section 3 GefStoffV (dangerous substances regulations) as very toxic (T+), toxic (T), carcinogenic, mutagenic or teratogenic;
2. Substances which are classified in the TRGS 905 or in the MAK list in the respective relevant version as
 - a) carcinogenic, EC category Carc.Cat. 1, Carc.Cat. 2 or Carc.Cat. 3 or classified as MAK grade K1, K2 or K3
 - b) teratogenic (reprotoxic), EC category Repr.Cat. 1, Repr.Cat. 2 or Repr.Cat. 3 or R_{E/F}1, R_{E/F}2 or R_{E/F}3
 - c) mutagenic, EC category Mut.Cat. 1, Mut.Cat. 2 or Mut.Cat. 3 or M1, M2, M3

Exceptions: the **phenol** and the **naphthalene** substances detected in the test chamber air are classified as **M3** and **K3** respectively.

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