

Criteria for allergy-friendly automobile interior spaces

Background information

The interior of an automobile is a tight space in which allergy sufferers may experience symptoms caused by the materials used in construction. However, the interior of a vehicle can also offer an allergic consumer a protective space to escape from harmful substances in the outside world.

For those with respiratory allergies, vapours from materials used to construct car interiors can be problematic, especially in new vehicles. Patients with contact allergies may react to direct contact with skin allergens such as nickel, which may be used in steering wheel construction. On the other hand, automobile air conditioners can be fitted with good and efficient pollen filters and thereby significantly improve driving safety for drivers with pollen allergies. This is a definite advantage over an automobile that merely circulates outdoor air through the car, thereby increasing the pollen concentration in the car's interior. Sneezing is accompanied by an unconscious reflex to close the eyes, which can significantly increase the chance of accident while driving.

Areas of the car which come into direct contact with the skin for longer periods of time are of particular concern to those with contact allergies, such as the steering wheel and gearshift and parts of the seats and armrests. Strong contact allergens such as nickel and chrome can cause significant problems.

An allergy-friendly automobile interior fulfils the following requirements:

1. Quantitative Risk Assessment

A quantitative risk assessment is carried out by the manufacturer during the development phase. All materials to be used in the interior are examined for potentially toxic components and also for components that may produce problematic odours which should be avoided in the car interior, or only emitted in very small concentrations, even when automobile parts become warm, in particular in the summer.

The top priority in the development, production, use and disposal of vehicles is the elimination of dangerous substances. Manufacturer specifications for suppliers include a list of substances and substance categories that should not be included in car components for the protection of consumers or the environment. These specifications are available to the designer and the materials specialist in the development stages as well as in choosing materials and when determining the manufacturing process. The heavy metals prohibited in the EU directive on end-of-life vehicles (lead, cadmium, mercury and hexavalent chromium) and the contents of the GADSL (Global Automotive Declarable Substance List) must also be observed. Automobile manufacturers may in some cases request detailed materials information from the relevant suppliers.

Interior emissions: Determination and elimination of harmful substances and odours.

For materials used in components for the passenger area and boot, additional emissions limits apply, which must be observed in supplying particular construction components. The regular reduction of interior emissions is an important aspect of component and materials development.

Component measurement in measurement chamber of 1 m³ according to VDA 276

In order to examine the materials used in a car interior, a contaminant-free emissions testing chamber of 1 m³ size is used. The test is carried out analogous to or in reference to the VDA 276 - part 1 with specific provisions. In addition, an odour analysis according to VDA 270 is to be carried out by an accredited testing institute.

Analysis of automobile interior air.

Contamination of interior air through volatile and semi-volatile organic compounds (VOC and SVOC) is caused by emissions from materials used (plastics, foams, insulating materials, leather, textiles, wool, elastomers, etc). A definitive assessment of interior emissions must be carried out.

To determine organic emissions levels, the vehicle is equipped with the necessary measurement technology and tested with test programmes and measurement cycles such as ISO 12219. All VOCs and SVOCs measured through this process are tested for their potential as allergens or in causing sensitisation and evaluated by ECARF. These substances are compiled in the list "sensitising substances" (see Annex).

Substances that come in direct contact with the skin are tested for the presence and concentration of or for the potential to emit the common contact allergens nickel and chromate. Additionally all component substances are tested for their potential as contact allergens. Current official limit amounts, such as the European Nickel Regulations, should be observed. Materials to be tested are compiled in the list "sensitising substances" (Annex).

The built-in indoor air filter with fine dust function is tested according to the following criteria based on realistic conditions:

Specifications for indoor air filter with fine dust function:			
		<u>New Filter</u>	<u>Used Filter*</u>
Filter efficiency	Filtration efficiency in %		
(according to DIN 71460, A4 dust)	Particle size		
	0.3-0.5µm	> 90	> 80
	0.5-1.0µm	>92	> 85
	1.0-5.0µm	> 97	> 97
	>5.0µm	> 99	> 99
according to DIN 71460, NaCl dust	0.3-0.5µm	>45	>45
	0.5-1.0µm	>55	>55
according to DIN 71460, part1, dust capacity	in g	>20 g	

(*Increase in pressure of 50 Pa in comparison with new filter)

2. Assessment of vehicle interior through test subjects

Because the combination of interior odours may cause unpredictable symptoms in patients suffering from respiratory allergies, which cannot be determined through evaluation of the individual elements, studies with test subjects in realistic conditions are carried out. Ten adult subjects with severe asthma (FEV₁ (Forced expiratory volume) 1 under 70% of the normal level) travel in the vehicle through city traffic over a period of 90 minutes. Before and after the test, lung function, exhalable nitric oxide, nasal airflow, blood pressure, heart rate and eye irritation are tested, among other levels.

The goal is that none of the test subjects should experience an acute or clinically relevant reaction in the membranes of the eyes or respiratory passages. The tests are carried out under constant medical supervision.

For a secure test of possible contact allergen symptoms caused by processed interior materials that come in direct contact with the skin, the materials are tested in a group of 20 patients with a severe nickel-chromate allergy in a skin test. The target parameter is that none of the patients should experience a skin reaction. The application of the material is made on the subjects' back. The material should be applied in a test object of at least 5 mm in diameter. The application period lasts 48 hours, and the test results are compiled after 48 and 72 hours. The surface materials of the following components must be tested:

- Steering wheel
- Seat covers including headrest
- Door interior panels, arm rests
- Arm rests and sides of centre console
- Seat belts
- Floor carpeting
- Gear shift
- Seat back panels

Other special assessments must only be carried out as relevant for the specific vehicle type.

3. Aromas and fragrances

The use of aromas in vehicle interiors can be problematic for allergy sufferers; on the other hand, there is a definite demand for the use of fragrances, also from those with allergies. Particular attention must be paid to the substances used in fragrances, as many of them are known allergy triggers. Among the many available fragrances, it is possible to choose those that are suitable for allergic persons; there are even essential oils that have a calming effect on the respiratory passages. If aromas are to be used, suitable fragrance mixtures must be provided for the equipment available in the vehicle.

Interior fragrances are tested through clinical subject trials. Analogous to the vehicle interior test (see above), the test should demonstrate that the manufacturer's recommended fragrances cause no reaction in the membranes of the eyes, nose and bronchial tubes in at least 10 persons with pathological hypersensitivity of the eyes, nose and bronchial tubes.

4. Ionisation

Ionisation of interior air has been an option for the improvement of air quality for persons with respiratory illnesses in medical contexts for many years. If this technology is used in automobile interiors, it must be demonstrated that when used in a close interior space it has no negative effect on respiratory function and does not cause membrane irritation.

Analogous to the vehicle interior test (see above), the test should demonstrate that the manufacturer's recommended ionisation of automobile interior space cause no reaction in the membranes of the eyes, nose and bronchial tubes in at least ten persons with pathological hypersensitivity of the eyes, nose and bronchial tubes.

Annex: Interior substances to be tested:

The following list includes those substances that qualify as potential allergy triggers or health hazards according to current technological knowledge. Still, each case must be considered carefully, according to the components in which the substances are present and the degree to which persons in the vehicle have direct or, in the case of airborne substances, aerogen contact to them. Fixed limit amounts are therefore not useful; instead, as in cosmetics, the exposure risk must be calculated for each individual substance. The manufacturer must carry out a risk assessment.

Substance	[CAS number]	Measurement method / notes
Acrylate		In individual substances
Acrylnitril	107-13-1	BG, DFG, HSE, INRS, NIOSH, OSHA
2-Aminoethanol	141-43-5	NIOSH / Contact allergen in colourants, coolants, lubricants
Bisphenol A (BPA)	80-05-7	Starting substance for synthesis of polymer plastics
<i>n</i> -Butylacrylat	141-32-2	INRS / Softening components in acryl resin (lacquers)
<i>p</i> -tert-Butylphenol		Eye and skin irritation
5-Chlor-2-methyl-2,3-dihydroisothiazol-3-on and 2-Methyl-2,3-dihydroisothiazol-3-on – Mixture in the ratio 3:1	26172-55-4	
Chrome	7440-47-3	HSE, NIOSH (calculated as chrome) (Metal and Chrome (III) compounds)
Chrome (VI) compounds		DFG, NIOSH (calculated as chrome) including lead chromate (in the form of dust or aerosols, excluding those basically insoluble in water, i.e. barium chromate) see zinc chromate
Colophonium	8050-09-7	
4,4'-Diaminodiphenylmethane	101-77-9	OSHA
1,3-Dichloropropene (cis and trans)	542-75-6	
Diethanolamine	111-42-2	Reaction with nitrosating agents can lead to production of carcinogenic N-Nitrosodiethanolamine.
1,4-Dihydroxybenzene	123-31-9	NIOSH
Disulfiram	97-77-8	OSHA
Ethyl acrylate	140-88-5	INRS, NIOSH
Ethylhexyl acrylate	103-11-7	
Formaldehyde	50-00-0	DFG, HSE, NIOSH, OSHA
Glutardialdehyde	111-30-8	
Isocyanate (Monomer and prepolymer)		HSE (measured as NCO)
Latex		
D-Limonene	5989-27-5	
Methyl acrylate	96-33-3	INRS, NIOSH
Methyl methacrylate	80-62-6	INRS, NIOSH
Nickel	7440-02-0	Nickel compounds from which nickel is bio-available should be treated as nickel metal
Nickel compounds, insoluble		(Nickeloxide and -sulfide) calculated as Ni [7440-02-0]
2-Octyl-2H-isothiazol-3-on	26530-20-1	

o-Phenylenediamine	95-54-5	
p-Phenylenediamine	106-50-3	
1,2-Epoxy-3-phenoxypropane	122-60-1	NIOSH
Phthalic acid anhydride	85-44-9	NIOSH
Pyrethrum	8003-34-7	NIOSH / S not valid for insecticide substances.
Thiram	137-26-8	NIOSH /Reaction with nitrosating agents can produce carcinogenic N-Nitrosodimethylamines.
Platinum compounds		NIOSH (calculated as Pt [7440-06-4]) S valid only for certain complex salts
Phenylhydrazine	100-63-0	NIOSH
Natrium diethyldithiocarbamate	148-18-5	
Maleic anhydride	108-31-6	NIOSH, OSHA
1,1-Dimethylhydrazine	57-14-7	NIOSH
1,2-Dimethylhydrazine	540-73-8	
Cobalt	7440-48-4	BG, HSE,
1-Chlorine-2,3-epoxypropane (Epichlorohydrin)	106-89-8	BG, DFG, NIOSH / Epoxid resin components
2-Butyne-1,4-diol	110-65-6	Use in PU, softeners, flame retardants
1-n-Butoxy-2,3-epoxypropane	2426-08-6	NIOSH
1-Allyloxy-2,3-epoxypropane	106-92-3	NIOSH
Mercury (Vapour and aerosol)	7439-97-6	HSE, NIOSH, OSHA
Mercury compounds, organic		NIOSH / (calculated as Hg) (see also methyl mercury)
Mercury compounds, inorganic		(calculated as Hg)
Subtilisins	1395-21-7 ; 9014-01-1	as crystalline active enzymes
Terpentine oil	8006-64-2	NIOSH
p-Toluidine	106-49-0	
Toluene-2,4-diamine	95-80-7	
Trimellitic acid anhydride (Smoke/dust)	552-30-7	NIOSH, OSHA
2,4,6-Picric acid (Trinitrophenol)	88-89-1	NIOSH
2,4,6-Trinitrotoluene	118-96-7	OSHA (and isomers in technical mixtures)
Zink chromate (calculated as Cr)	13530-65-9	NIOSH
α-Amylase		Enzymes used for conversion to starch
Benomyl	17804-35-2	OSHA / Fungicide not permitted in Central Europe (Methyl-1-(butylcarbamoyle)benzimidazol-2-ylcarbamate)
p-Benzoquinone	106-51-4	NIOSH Metabolic product on exposure of humans to benzene (fuelling)
Acrylamide	79-06-1	OSHA
Methylchloroacetate	96-34-4	INRS / Aroma production
Portland cement (Dust)	68475-76-3	
Nickel salts, soluble		NIOSH (calculated as Ni [7440-02-0])
4-(2-Nitrobutyl)-morpholine (70 Gew.-%)	2224-44-4	
Methyl mercury	22967-92-6	
N-Methyl-N,2,4,6-tetranitroaniline	479-45-8	NIOSH
Naled	300-76-5	OSHA
Wood dust (excluding beech, oak)		S valid often for exotic wood, rarely for native wood
Hydrazine	302-01-2	BG, DFG, NIOSH, OSHA
Iodine	7553-56-2	OSHA
Iodoform	75-47-8	
Grain flour dust (Rye, wheat)		
Cyanamide	420-04-2	



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1,2-Ethylenediamine	107-15-3	NIOSH, OSHA
Enzyme, proteolytic	1395-21-7	In reference to 100% pure crystalline enzyme activity