

Exposure description

“The manufacture and transport of asphalt”

June 2006

1 General

Paragraphs 7 and 9 of the German Ordinance on Hazardous Substances (GefStoffV) [1] request employers to determine whether the occupational exposure limit values are maintained. This can be checked by taking measurements at the workplace or by other equivalent means. If no occupational exposure limit values are available, then the effectiveness of the protective measures must be proven using suitable evaluation methods.

This exposure description presents an assessment method for materials without occupational exposure limit values. For the activities described, there is an adequate number of workplace analyses with clear results available and, owing to the process, no changes are to be expected in future. These results can thus be directly used to assess the concentration in the air at working locations i.e. no further measurements are required.

Whatever results are presented here, the hazard must be assessed for the activity considered in accordance with paragraph 5 of the German Occupational Health and Safety Act (ArbSchG) [2], paragraph 7 of the German Ordinance on Hazardous Substances (GefStoffV) and paragraph 3 of the German Workplace Safety Ordinance (BetrSichV) [3]. The obligations to use materials and/or processes with low risk, to pay attention to the priority of the protective measures and to inform and instruct the employees etc. all continue to apply.

2 Application area

This exposure description deals with the manufacture and transport of bituminous asphalt as rolled or mastic asphalt conforming to DIN 55946, part 1. The description does not apply if tar or pitch is contained in the binding agent as specified in DIN 55946, part 2.

Manufacture is usually carried out in stationary mixing plants. “Plant” in this exposure description means those parts which serve directly to manufacture asphalt by mixing the separate components and possibly the temporary storage in a silo (so not the storage area for the mineral aggregates etc.). It is differentiated here between open and enclosed types of plants. Enclosing plants started in the second half of the 1970s as a direct consequence of the German federal pollution control act.

To transport rolled asphalt, usually open lorries are used, which have to be covered with a tarpaulin to protect the mixture. Mastic asphalt is transported to the building site in special lorries, consisting of a closed heated tank with a mixer.

A special exposure description [4] applies for the laying of rolled asphalt in road construction.

If, for practical reasons, the working procedures mentioned in section 3 can not be followed (e.g. temporary storage of rolled asphalt outside of the heated silo) this exposure description can not be used.

3 Working process

3.1 Manufacture of asphalt

Bitumen is used to bind the mineral components of the mixture. Measured amounts of pre-dried mineral materials mixtures are added to a mixing machine. According to “the additional technical, contractual conditions for road building with asphalt”, 1998 version (ZTV Asphalt-StB 94, issue 98), the maximum permissible temperature for the manufacture of rolled asphalt is 190 °C, and for mastic asphalt it is 250 °C. According to DIN 18560 part 1, temperatures from 220 to 250 °C are permissible for the manufacture of mastic asphalt floor covering in the building trade. Materials are added and mixed in a plant which is largely enclosed. The mixing procedure is directed from a control room at some distance from the plant, so that no personnel need to work inside the plant during the manufacturing process. To maintain production, the plant must be continuously supplied with mineral materials. A wheel loader is used to do this, which collects the mineral materials from free storage and supplies it to dosing units. The driver of the wheel loader is generally not exposed to any vapours or fumes from bitumen whilst doing this work. Exposure can only occur if employees have to spend time in the plant during production. In particular, this can be the case for:

- the manual addition of additives,
- doing checking rounds and
- fixing operational problems which suddenly occur.

For plants where additives are still added manually, the proportion of time involved depends upon the exact job. The time spent on a daily basis to do rounds and to fix problems is in the region of a few minutes. Routine maintenance work and larger repairs are done outside of normal mixing times.

When assessing the exposure, it must be taken into account, that there is a certain background level on the site of an asphalt mixing plant (table 1). This background level can consist of vapours and aerosols from bitumen or of substances which affect the measurement process.

3.2 Transport

3.2.1 Rolled asphalt

Loading is from silos or directly from the plants. To avoid the mixture sticking to the lorry, before loading, a separating material (e.g. crushed sand, emulsions) is spread over the surface of the container. The use of diesel fuel¹⁾ or heating oil¹⁾ is inadmissible for reasons of quality and for the protection of the environment. The mixture falls free from a height of approx. 2 m from the mixer or silo, onto the cargo surface of the lorry. The driver will be exposed to vapours and aerosol of bitumen if they leave their cab during the loading process. Before transporting, the cargo must be covered with a tarpaulin. During the covering and lashing down, the driver is in the direct vicinity of the cargo. The exposure during the loading and covering of the load is approx. 5-12 minutes.

The transport to the building site is not associated with any exposure. Once on the building site, the tarpaulin will first be removed, whereby less exposure than that during covering is to be expected; with a duration of less than 4 minutes. The load of asphalt mixture is tipped directly into the road paver's input opening. During the unloading procedure, the driver is in the

¹⁾ The use of these materials prohibits the use of this exposure description.

cab of the lorry. Possible exposure to vapours and aerosol of bitumen depends on the duration of the unloading, the ventilation of the driver's cab and on the weather conditions (wind flow and direction).

Depending on the size of the job and the distance between the asphalt mixing works and the building site, up to 6 transport cycles per person and shift are possible.

3.2.2 Mastic asphalt

Usually the mixer discharges directly down into the input opening of the mixing container of a special vehicle.

Exposure to vapour and aerosol of bitumen is possible if the driver watches the unloading process outside of the driver's cab, in the direct vicinity of the vehicle, or closes the flaps to the transport container. Loading one unit (one mixing container) takes up to 15 minutes.

The transport to the building site is not associated with any exposure. On the building site, the driver dispenses the mastic asphalt either into the asphalt finisher or into smaller containers (wheelbarrows, buckets, canisters). The exposure to vapour and aerosol of bitumen depends on the duration of the unloading, the jobs actually done and on the weather conditions (wind flow and direction).

Depending on the size of the job and the distance between the asphalt mixing plant and the building site, up to 3 transport cycles per person and shift are usual.

4 Hazardous substances

Rolled and mastic asphalt both contain bitumen as a binding agent - this is a mixture of various organic substances, mostly long molecule hydrocarbons produced during the distillation of crude oil. An analysis of the common, commercial types of bitumen showed 1.2 to 2.7 mg/kg benzo[a]pyrene ([5]; there are further details on the individual polycyclic aromatic hydrocarbons (PAH) and heterocyclic aromatic hydrocarbons with at least one sulphur atom (S-PAH)). This level is more than a factor of 10 beneath the specific limit for this material of 50 mg/kg benzo[a]pyrene to be assessed as carcinogenic according to appendix I of the European Directive 67/548/EEC [6].

During the hot treatment of bitumen to manufacture asphalt, vapours and aerosols are produced. The measurement process registers all organic compound with aliphatic C-H bonds [7]. During the handling and processing of the mineral components, mineral dust can result which can be inhaled and enter the alveoli in the lungs, particularly quartz dust, which is not the subject of this exposure description.

5 Exposure to hazardous substances

This exposure description is based on assessments of workplace measurements during the manufacture and transport of rolled and mastic asphalt. The concentrations of vapours and aerosols released from bitumen were determined.

More than 100 measurements were made over the period 1997 - 2000;

manufacture of asphalt was accounted for by

- 64 measurements at fixed locations in 29 asphalt mixing plants, at the following locations
 - Mixing platform, next to the mixer
 - Mixer output, transfer to the hoist bucket
 - At the point where mineral material is added, above the mixer
 - Control room;
- 6 measurements taken by people wearing test equipment during jobs on the mixing site (material transport with the wheel loader, maintenance work);
- 24 fixed location measurements to determine the background levels (measured e.g. in the office, washroom, staffroom).

transport of asphalt

- 18 measurements made by people wearing test equipment whilst the lorry was being loaded and during the transport to the building site, including the unloading procedure, for rolled asphalt. If, when transporting mastic asphalt to a building site, the lorry driver was also involved with unloading and with the transport from the lorry to the site of use, then these jobs were also measured.

Measurements were made both in open and in completely enclosed plants. All measurements were made during mixing. Table 1 summarises the series of measurements of vapour and aerosol of bitumen.

Table 1: Vapour and aerosols of bitumen when manufacturing and transporting asphalt (mg/m³)

Number	Minimum value	50 % value	95 % value	Maximum Value
in the mixing plant				
54	0.25	6.00	30.35	45.20
Asphalt manufacture, control room				
10	0.50	0.90	2.50	2.50
Wheel loader driver / outside area				
6	0.50	-	-	0.90
Background concentration				
24	0.40	0.90	2.51	3.90
Asphalt transport				
18	0.40	1.20	4.25	5.30

The large variation in the measurements for asphalt manufacture is explained by the nature of each mixing plant, the type of bitumen, the processing temperature and the nature of the manufactured product (rolled or mastic asphalt). The values measured in enclosed plants were thus significantly higher than in open or only partially enclosed plants. Significantly higher values were measured for rolled asphalt compared to mastic asphalt.

During the transport of the asphalt (including loading and unloading) the variation in the measurements was slight. The applicable parameters for the manufacture of rolled or mastic asphalt are obviously only of secondary importance for the amount of exposure. As in the manufacture, during transport the measurements for mastic asphalt were less than for rolled

asphalt, as mastic asphalt is transported in closed mixing containers and rolled asphalt is transported on the back of lorries.

6 Assessment

The working procedures described in section 3 represent the current state of technology in the manufacture and transport of asphalt and are associated with the lowest exposure.

The exposure to mineral dusts, particularly quartz dust must be assessed separately and is not treated in this exposure description.

6.1 The manufacture of asphalt

The measurements show that as far as the vapour and aerosol of bitumen go, work is possible in an asphalt mixing plants without additional protective measures, provided no longer than 60 minutes is spent in the mixing plant (the location with the highest exposure in the manufacture of asphalt).

6.2 The transport of asphalt

When transporting asphalt with a lorry (including loading and unloading), the measurements prove that, as far as vapour and aerosol of bitumen are concerned, work is possible without any further protective measures.

7 Recommendations

On the basis of an eight hour working day, work is possible without additional protective measures, if

- the time spent in the mixing plant is restricted to a maximum of 60 minutes and
- during the transport of the mastic asphalt, the driver is not involved in the application of the asphalt (e.g. dispensing the mastic asphalt into smaller containers such as wheelbarrows, buckets, canisters or manually transporting it directly to the point of use).

On the basis of the available results, exposure measurements for vapour and aerosol of bitumen are not necessary.

Time spent in the mixing plant should be restricted to that which is absolutely necessary. More extensive maintenance work within the mixing plant, which is likely to lead to an overall exposure of more than 60 minutes/shift, should only be carried out when the plant is at rest and after well ventilating the working area.

If more than 60 minutes/shift are spent in the mixing system, then a suitable respirator must be worn (respirator with a filter to protection level A-P2). If necessary, the affected staff should be given a check-up as specified by the German employers' liability insurance association in their guideline G 26, "Respiratory protection" [8]. The maximum time limits for wearing respirators must be observed [9].

Additives should be added automatically, i.e. not be added manually from the mixing platform directly into the mixer. The latest state of technology is e.g. to blow in the additives, to use screw conveyors to supply the additives from closed silos or to add additives into the mixer in sacks via an external conveyor belt. When certain additives are used (e.g. fibres or

colour pigments) then special regulations should be followed, such as e.g. wearing a respirator.

Any exposure to mineral dust, particularly quartz dust, must be separately determined and assessed.

8 Application recommendation

The applier of this exposure description needs to verify the validity of requirements and document the result of this during procedural changes and otherwise at regular intervals, but at least once annually. Amongst others, this includes verifying the continued validity of this exposure description. Such verification can take place within the scope of hazard assessment pursuant to § 5 of the German Occupational Health and Safety Act (ArbSchG), § 7 of the Ordinance on Hazardous Substances (GefStoffV) or alternatively § 3 of the Workplace Safety Ordinance (BetrSichV).

This exposure description provides employers with practically-based advice on how to meet their obligations, in particular pursuant to § 9 sect. 8 of the German Ordinance on Hazardous Substances. Under application of this exposure description, other requirements of the Ordinance on Hazardous Substances remain in force, in particular concerning the determination of information and hazard assessment (§ 7), the use of substances and/or processes with a low risk (as well as the documentation of a possible rejection of the use of a substitute, § 9 sect. 1), the obligation to observe the order of priority of protective measures (§ 9 sect. 2), as well as the obligation to train and brief employees and to prepare written directives (§ 14).

9 Reviews

This exposure description was first approved in June 1999, reworked in March 2005 when the new German Ordinance on Hazardous Substances came into power and in July 2006 updates. It will be reviewed at intervals of 12 months. Should changes be necessary, they will be published.

Literature

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