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Technical Rules for Hazardous Substances	Activities with potentially asbestos- containing minerals and mixtures and products manufactured from same	TRGS 517
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The Technical Rules for Hazardous Substances (TRGS) reflect the state of the art, the state of occupational health and occupational hygiene as well as other sound work-scientific knowledge relating to activities involving hazardous substances including their classification and labelling. The

Committee on Hazardous Substances (AGS)

compiles and/or adapts these rules. They are published by the Federal Ministry of Labour and Social Affairs in the Joint Ministerial Gazette (GMBI).

This TRGS specifies, within its scope of application, the requirements of the Gefahrstoffverordnung / [Hazardous Substances Ordinance] (GefStoffV). By complying with these Technical Rules, the employer may therefore assume that the corresponding requirements of the Ordinance have been fulfilled. Should the employer choose a different solution, he must then achieve at least the same level of safety and the same health protection for his employees.

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1 Scope of Application

- (1) This TRGS applies to activities with potentially asbestos-containing mineral raw materials in accordance with Annex 1 and mixtures and products produced from them and describes the protective measures to be applied to these activities.
- (2) This TRGS applies especially to
1. the extraction and purification of naturally occurring mineral raw materials containing asbestos in quarries (e.g. gravel, grit, crushed sand, filler),
 2. the further processing of asbestos-containing mineral raw materials and mixtures and products manufactured from them in construction and civil engineering (e.g. road and track construction, concrete, asphalt),
 3. the reprocessing (recycling) and reuse in road construction (e.g. the treatment and reincorporation of recycled materials, the manufacture of asphalt),
 4. the processing of natural stone (e.g. soapstone in construction furnaces),
 5. cold milling machines in traffic areas.
- (3) This TRGS also applies to activities
1. when excavating and securing underground cavities in rock containing asbestos,
 2. with asbestos-containing talc as a filler, separating and lubricant material (e.g. in cable, tire and rubber goods production),
 3. with asbestos fillers and additives for other purposes (e.g. for asphalt and concrete manufacturing, concrete restoration).
- (4) For further activities with potentially asbestos-containing materials within the meaning of this TRGS not listed in paragraphs 2 and 3, the terms in point 3.1 paragraph 3 should be applied accordingly.
- (5) The employer may assume that the bulk content of asbestos in mineral raw materials, as, for example, occurs in quarries in the Federal Republic of Germany, is less than 0.1 per cent, so that the ban on manufacture and use in accordance with § 16 paragraph 2 in conjunction with Annex II No. 1 paragraph 2 of the Ordinance on Hazardous Substances (GefStoffV) [1] is not affected. Even if the mass content of asbestos is less than 0.1 per cent, exposure to asbestos fibers can occur, which necessitates the following protective measures.
- (6) The Bekanntmachung zu Gefahrstoffen / [Announcement on Hazardous Substances] (BekGS) 910 of the AGS [2] describes the following exposure-risk relationship for asbestos:
1. Acceptable risk of 4:10,000 additional cases of illness due to asbestos at 10,000 F/m³
 2. Tolerable risk of 4:1,000 additional cases of illness due to asbestos at 100,000 F/m³
- based on a working life period of 40 years with continuous exposure during the working day.

2 Definitions

2.1 Mineral raw material

Mineral raw materials within the meaning of this TRGS are substances naturally occurring in the Earth's crust that are used industrially or in trade. These include all raw materials known as stones and earth, such as, for example, natural stone, gravel and sands, clays.

2.2 Asbestos

(1) Asbestos minerals are the following fibrous silicates:

1. Chrysotile (a mineral from the serpentine group),
2. amphibole asbestos actinolite, amosite, anthophyllite, crocidolite and tremolite.

(2) The mineral raw materials covered by this technical rule are usually substances containing small amounts of asbestos minerals created by geological processes.

2.3 Mass content of asbestos

The mass content of asbestos within the meaning of this TRGS does not necessarily correspond to the mass fraction of the asbestos minerals, because the extent to which asbestos fibers arise from the asbestos minerals can only be determined by mechanical crushing. The mass content of asbestos can, therefore, change due to further working or processing. The evaluation rules for the analytical methods described in the Annex 2 Parts 1 to 4 are crucial for the determination of the mass content of asbestos.

2.4 Asbestos fibers

Fibers are designated as asbestos fibers, which based on their composition should be assigned to the six asbestos minerals [3] and which exhibit dimensions determined by the WHO (length > 5 µm, diameter < 3 µm, length to-diameter ratio > 3:1) [4]. It makes no difference whether an asbestos fiber has been released from a fibrous or non-fibrous deposit of an asbestos mineral. Such a distinction cannot usually be made analytically with certainty based on a single particle.

2.5 Asbestos-containing material

Asbestos-containing material in the sense of this TRGS are mineral raw materials and mixtures thereof and products in which asbestos has been demonstrated (see point 3.2.2).

2.6 Production

All process steps that expose the rock. These include:

1. the creation of access to the areas earmarked for mining,
2. the preparation and execution of demolition or another extraction process,
3. the transport of the rock for treatment.

2.7 Preparation

Crushing, grading, sorting, dusting and storage of the rock and the material handling within the treatment plant.

2.8 Further processing

Further processing within the meaning of this TRGS is the use of asbestos-containing mineral raw materials for the production of building materials and components, including acquisition and transport.

2.9 Reprocessing (recycling)

Reprocessing (recycling) within the meaning of this TRGS includes all activities and processes, in which construction materials from demolition materials from building construction and civil engineering (for example, road construction waste, concrete, and masonry demolition materials) are prepared for recycling. The reprocessing includes also the storage of the material for later recycling.

2.10 Recycling

Recycling within the meaning of this TRGS includes all activities and procedures for the processing of recycled material for the purpose of the manufacture of mixtures and products. Recycling starts as soon as material prepared for the manufacture of new mixtures and products is received. Recycling is equated with further processing within the meaning of this TRGS.

2.11 Competent person

Competent persons are those who are entrusted with asbestos-related problems in activities with asbestos-containing materials, so that they are able to assess the occupational health hazard situation and advise the employer in terms of protective measures in accordance with this TRGS. To do this they must, in particular, have the knowledge listed in Annex 4.

2.12 Building contractor or client

A building contractor or client in the sense of points 5.6 and 5.7 is the person who placed an order to carry out a tunnel construction project or milling works.

2.13 Contractor

Contractors within the meaning of points 5.6 and 5.7 are usually construction companies. These or their subcontractors are an employer within the meaning of this TRGS.

3 Information Gathering and Risk Assessment

3.1 General Requirements

(1) In the extraction, processing, reprocessing, further processing and recycling of particular naturally occurring rocks (see Annex 1) the presence of asbestos in the mineral

raw material, as well as in the mixtures produced from it and products and, as a result, the exposure of workers in related activities cannot be ruled out. The same applies when excavating and securing underground cavities. In addition, further rules apply to the opening and securing of underground cavities in accordance with point 5.6.

(2) The employer may assume that asbestos does not exist in the collection, processing, reprocessing, further processing and recycling of mineral raw materials from rocks, which are not listed in Annex 1. This is not true, if asbestos from mineral raw materials was added to mixtures and products to improve their characteristics.

(3) To assess working conditions according to § 6 GefStoffV, the employer must, before commencing activities with potentially asbestos-containing materials, competently determine by means of appropriate measures referred to in point 3.2 and evaluate in accordance with point 3.3 whether asbestos exposure for employees should be expected and its extent.

(4) If no asbestos was able to be substantiated as part of the risk assessment in the mineral raw materials or the mixtures or products produced from them, this TRGS should not be applied to the activities with the material.

3.2 Determination

(1) Measurements must be carried out in accordance with points 3.2.2 and 3.2.3 only by measuring stations, which have the necessary expertise and the necessary equipment.

(2) Due to the special problems in the identification of asbestos, it is advisable to hire accredited measurement stations [5].

3.2.1 Potentially Asbestos-Containing Rocks

(1) If one of the rock types listed in Annex 1 is extracted, processed, further processed or recycled, it must be assumed that asbestos fibers can be freed during the activities.

(2) The protective measures listed in this technical rule must be used, if asbestos has been demonstrated in the determination of the mass content of asbestos in the mineral raw material processed or reprocessed or the mixtures or products manufactured from them (see point 3.2.2).

3.2.2 Determining the Mass Content of Asbestos

(1) The detection of asbestos in the mineral raw materials or the mixtures or products produced from them is then confirmed, when in at least three samples for the determination of the mass content of asbestos in at least one analysis the lower detection limit specified in paragraph 2 was not breached (under standard conditions 0.008% by mass).

(2) To determine the mass content of asbestos, depending on the characteristics of the material, one of the processes 1 to 4 listed in Annex 2 is to be applied.

(3) Then the determination of the mass content of asbestos when

1. the material is in powder form (e.g. talcum powder, rock flour, filter dust), is

performed using Process 1 in Annex 2.

2. material already in preparation (e.g. gravel and aggregates) or reprocessing (e.g. when milling road surfaces) can be analyzed using Process 2 described in Annex 2.
3. fine-grained or broken materials (e.g. crushed sand, chippings), which exist as a product, using Process 3 listed in Annex 2.
4. compact materials (e.g. soapstone pieces, natural stone), for which inhalable dusts can be created on use (e.g. by drilling, sawing, milling) using Procedure 4 described in Annex 2.

3.2.3 Determination of Asbestos Exposure

- (1) If asbestos was detected in the material, asbestos exposure must be determined in accordance with TRGS 402 [5].
- (2) The determination of the asbestos fiber concentration is made by the scanning electron microscopic method designed for the monitoring of workplaces in accordance with BGI (Berufsgenossenschaftliche Informationen und Grundsätze für Sicherheit und Gesundheit am Arbeitsplatz/[Information on and principles of workplace safety and health issued by the Government Safety Association]) 505-46 [6]. For the determination of an asbestos fiber concentration of less than 10,000 F/m³, the criteria set down in Annex 3 must be applied.

3.3 Risk Assessment

- (1) The risk assessment in relation to the work place and work activities is carried out by a competent person [7]. When doing so the following aspects should be taken into account in particular:
 1. The extent and duration of the inhalation exposure,
 2. Working conditions and work practices, including work equipment,
 3. required protective measures.
- (2) When a change in the operating conditions occurs, which can lead to a major change to the hazard situation, the risk assessment should be carried out again.
- (3) The result of the risk assessment must be documented.

3.4 Event-Related Advice

- (1) The employer is obliged to obtain event related advice themselves or have it obtained by a supervisor contracted by them with regard to the protective measures to be taken to minimize the risks related to exposure to asbestos, where they or the supervisor does not have sufficient expertise. Alternatively to the requirements of clause 1, the procedures in the industry solution "Dust-free ablation of asphalt pavements with cold milling machines" [23] can be followed.
- (2) When a change in the operating conditions occurs, which can lead to a major change to the hazard situation, the event-related risk assessment should be carried out again.

3.5 Notification to Authorities

- (1) If the investigation referred to in point 3.2.3 has revealed that workers are exposed to asbestos during their activities or may be exposed, the employer must notify these activities of the authority.
- (2) The notification to authority must be carried out by the employer before the start of the activity and must contain the following information:
 1. The location of the work site;
 2. The activities and procedures,
 3. The number of workers concerned,
 4. The beginning and duration of the activities,
 5. Measures to limit asbestos exposure for workers.
- (3) For activities and procedures of a similar nature a single enterprise-related notification suffices. The notification must be repeated where there is a significant change in the working conditions.
- (4) Rules to be implemented can be determined (see points 5.1–5.7).

3.6 Selection of Protective Measures

The protective measures should be selected and documented according to the result of the risk assessment (see points 4 and 5).

3.7 Review of the Effectiveness of the Protective Measures

The effectiveness of the protective measures should be reviewed after implementing the measures and then at regular intervals, at least once per year.

4 General Protective Measures

- (1) For activities with asbestos-containing materials, the breathing air at the workplaces of workers must, insofar as this is possible at the state of the art, be free from asbestos fibers. Where the asbestos fiber concentration falls below 10,000 F/m³, as a minimum the basic measures to protect of the workers referred to in point 5 of the TRGS 500 [8] must be carried out.
- (2) Where the asbestos fiber concentration exceeds 10,000 F/m³, the following ranking of protective measures must be complied with to minimize risk:
 1. Use of low-emission work procedures and work equipment,
 2. Implementation of collective protection measures at the source of danger, such as e.g. extraction, aeration and ventilation and appropriate organizational measures,
 3. Use of personal protective equipment, if a risk cannot be prevented by the

measures referred to in points 1 and 2.

4.1 Machinery and Equipment

Machinery and equipment must be selected and operated, so that as few asbestos fibers as possible are released.

4.2 Design of Work Spaces

(1) Work spaces, where activities are performed, in which asbestos fibers can be released, must be set up and maintained to avoid deposition surfaces for asbestos fibers and so that the areas are easy to clean.

(2) This shall not apply in the case of construction sites.

4.3 Ventilation Measures

Dust collection and ventilation of the workplace must be determined and implemented at the state of the art [9].

4.4 Air Return

Extracted air containing asbestos fibers can only be returned to the workspace if it has been sufficiently cleaned using procedures recognized by the government or the employer's liability insurance association [10].

4.5 Hygienic Facilities

Workers must be provided with as a minimum

1. separate storage facilities for work and protective clothing on side and street clothes on the other side, as well as
2. laundry facilities on-site.

4.6 Maintenance and Testing

(1) Facilities to collect, precipitate and deposit asbestos fibers must be inspected for correct function, maintained and, where necessary, repaired according to the results of the risk assessment, taking into account the time intervals specified by the manufacturer, but at least annually.

(2) The inspections shall be documented. The documents on this must be retained for at least three years.

4.7 Material Storage and Material Handling

- (1) Asbestos-containing materials should be stored so that no dust is released.
- (2) The material cover needs, as far as this is technically possible, to be free of dust.

4.8 Cleaning

Workrooms, workplaces, roads, facilities, machinery and equipment must be kept clean and should be cleaned regularly. The cleaning must be carried out so that the release and dispersion of asbestos fibers is kept to the lowest possible minimum. The cleaning of the work area by sweeping without dust-binding measures or blowing off dust deposits with compressed air is not permitted in any circumstances.

4.9 Waste and Residues

- (1) When collecting waste (e.g. contaminated personal protective equipment) and residues (e.g. fly ash), as well as their preparation for transport, the release of dust must be prevented by appropriate measures at the state of the art, e.g. by moistening, covering or storage in closed containers.
- (2) Wastes must be prepared in accordance with the waste legislation of the Federal and State Governments (the Kreislaufwirtschaftsgesetz/[Federal Recycling Act], LAGA Guidelines on the Disposal of Waste Containing Asbestos) and disposed of properly and without causing harm.

4.10 Definition of Responsibilities, Supervision

Activities involving materials containing asbestos must be conducted by qualified personnel and supervised. The employer must ensure that the required organizational requirements are met. Alternatively to the requirements of clause 1, the process in accordance with the industry solution "Dust-free ablation of asphalt pavements with cold milling"[23], can be followed.

4.11 Limiting the Number of Persons Exposed

Work areas, in which according to the criterion in point 3.2.3 paragraph 2 an asbestos fiber concentration of 10,000 F/m³ has been exceeded, must be signposted in an appropriate manner. Unauthorized access to these workplaces must be forbidden.

4.12 Minimizing Exposure

Staying in work areas with an asbestos fiber concentration of more than 10,000 F/m³ must be limited to the extent required for the associated activity.

4.13 Information and Training

- (1) The employer must create a workspace and activity-related written operating guideline [11]. This must be reviewed periodically and updated if necessary.
- (2) Employees must be instructed verbally on the basis of the operating guideline on the hazards occurring and protective measures [11].
- (3) The workplace related instruction must be delivered before taking up employment and then at least annually. In the framework of the correct use of respirators and protective clothing must be practiced. The content and timing of the training must be set down in writing and be confirmed by the signature of the instructed.
- (4) In addition, the employer must ensure that employees are screened on an occupational medicine-toxicological basis in accordance with § 14 paragraph 2 GefStoffV. This consultation is part of the training referred to in paragraph 3.
- (5) The employer must ensure for activities with asbestos-containing hazardous substances that the employees or their representative
 1. can check whether the provisions of the Gefahrstoffverordnung/[Ordinance on Hazardous Substances] and the provisions of this TRGS on risk assessment and determining measures – in particular for protective clothing and protective equipment – are respected,
 2. Are given access to the records of exposure levels – where available – and receive information on their meaning.
- (6) The employer must inform workers immediately if these can be exposed in operating conditions, which deviate from normal operations, to exceptionally elevated asbestos fiber concentrations. This may be particularly the case where there are malfunctions, certain maintenance works or accidents.
- (7) Further information rights of employees and their representation can be found in § 14 GefStoffV.
- (8) Workers must immediately notify any imminent major threat detected by them to safety and health, as well as any defect identified in the protective systems to the employer or the competent supervisors under the Arbeitsschutzgesetz/[Working Conditions Act].

4.14 Respiratory Protection Masks and Protective Clothing

- (1) Before beginning activities involving asbestos-containing materials the employer must determine which personal protective equipment to use and to make this available. The type and design of personal protective equipment must be selected according to the specific conditions of use¹.
- (2) At asbestos fiber concentrations from 10,000 F/m³ through to an asbestos fiber concentration of up to a 100,000 F/m³ as respiratory protective devices
 1. FFP2 particle filtering half masks for short-term activities (for example inspections),

¹ The employer must arrange occupational health screening when using respiratory protection devices from Groups 2 and 3 and offer occupational health screening when using respiratory protection devices from Group 1 [12, 22].

2. half masks with a P2 filter for long-term activities (e.g. implementation of repairs),
3. masks with blowers and a TM1P particulate filter

are suitable and must be worn accordingly [12].

(3) In areas with asbestos fiber concentrations of more than 100,000 F/m³ masks with a P3 particle filter must be worn [12]. For asbestos fiber concentrations of 300,000 F/m³ and higher

1. FFP3 particle filtering half masks for short-term activities (for example inspections),
2. half masks with a P3 filter for long-term activities (e.g. implementation of repairs) are suitable.

(4) The wearing of masks in the version specified under paragraph 3, Nos. 1 and 2 should be avoided by appropriate measures, since wearing such masks is connected with an increased physical load and the work is made significantly more difficult as a result. If this is not possible, masks with blowers and a TM2P particulate filter, if necessary with heating of the breathing air, should be deployed.

(5) In areas with asbestos fiber concentrations of more than 300,000 F/m³, masks with a blower and a TM3P particulate filter, if necessary with heating of the breathing air, should be deployed [12].

(6) When wearing breathing protection, the time limit on its wear under BGR/GUV-R 190 Annex 2 [12] must be adhered to.

(7) Employees must use the personal breathing protection provided as long as a hazard exists. Wearing burdensome personal protective equipment may not be a permanent measure according to § 7 paragraph 5 GefStoffV. Respiratory protection may not replace technical or organizational protective measures.

(8) Contaminated reusable suits must be cleaned, contaminated single-use suits must be disposed of.

4.15 Hiring of Contractors (Subcontractors)

(1) If outside firms are entrusted with activities involving materials containing asbestos, the employer as a contracting party must ensure that the outside firms are informed before the start of activities of the company-specific hazards of asbestos and the rules of conduct.

(2) The outside firms must ensure that their own staff are instructed in the applicable protective measures.

5 Complementary Protective Measures

Special requirements also apply to the general protective measures listed in point 4 for the following work areas and activities.

5.1 Extraction and Processing in Quarries

In addition to the general protection measures in point 4 of this TRGS, the following measures must be taken according to the hazard [13]:

5.1.1 Drill rigs

Drilling rigs must be equipped with a device for the extraction and separation of drilling dust.

5.1.2 Crushing and screening plants

(1) Crushing and screening plants must be enclosed at the state of the art.

(2) In particular at the discharge and transfer points, where encapsulation is not possible, the dust must be extracted. The exhaust air must be fed to a dust removal system with a sufficient degree of separation. The asbestos fiber concentration in the exhaust gas stream of the dust removal system may, pursuant to TA Luft (Technische Anleitung zur Reinhaltung der Luft/[Technical Instructions on Air Quality Control]) [14], not exceed 10,000 F/m³.

5.1.3 Filter Dusts

(1) The filter dust discharge in dust collection systems must be dust-proof in sealed bins or silos.

(2) Deposited dusts (such as from fabric filters, drilling device extraction, wet processes) must be permanently bound and collected in a dust-free manner.

5.1.4 Conveyors

(1) Conveyors must be encapsulated at the state of the art.

(2) Conveyor belt transfer points must be equipped with an extraction system or a water sprinkler or jet.

(3) The discharge height should be adjusted to the height of the accumulation.

(4) In the drop-off area material aprons must be installed and a water sprinkler or jet must be provided.

5.1.5 Material Storage and Material Handling

(1) To minimize the asbestos fiber concentration of the finished product, ultra-fine particles forming on the broken material must be separated, e.g. by air injection and exhaust or by using a wet process.

- (2) The crushed sand fraction 0/2 mm should be stored in closed silos.
- (3) Grain over 2 mm should be stored in at least three-sided enclosed material boxes.
- (4) Dumps and landfills must be protected by earthworks, windbreak planting, windbreak fences or by keeping moist.
- (5) The free fall height when loading of finished material grains on transport vehicles must be minimized by adjusting the discharge height to the height of the pour.
- (6) The truck-loading device must be equipped with dust extraction and/or water sprinkler or jet.

5.1.6 Vehicles, Earth-Moving Machinery and Mobile Equipment

- (1) Vehicles, earth-moving machinery (e.g. excavators, crawlers) and mobile equipment (e.g. drill rigs) with enclosed cabins must be equipped with air conditioning and dust filtering.
- (2) Windows and doors must be closed during operation.
- (3) Driver cabs must be cleaned regularly.

5.1.7 Roadways

- (1) Roadways in the system area (preparation and loading) must be sealed with a surface, for example, asphalt or concrete.
- (2) Sealed surfaces must be regularly cleaned (usually weekly) depending on the degree of contamination. Roadways must be moistened regularly.

5.1.8 Technical Equipment and Work Spaces

- (1) Permanent work stations in rooms (e.g. guidance and control stations) must be air-conditioned and supplied with sufficient filtered air. To avoid contamination, transition zones (e.g. entrance ways) must be provided for cleaning or changing work clothing and breathing protection devices.
- (2) Work spaces and transition zones must be cleanable with employer's liability insurance association or government recognized dust suction units of dust class H according to DIN EN 60335-2-69 [15].
- (3) Filter equipment must not be operated in the positive pressure range.

5.1.9 Social Facilities

A "black-white facility" must be provided to staff as a changing room. A boot washer must be set up before the "black area". A break and rest area must be set up for staff in the "white area".

5.1.10 Protective Clothing

- (1) Protective clothing must be cleaned when leaving areas where there is exposure to asbestos (e.g. by vacuuming). The protective clothing must be taken off when leaving the areas.
- (2) Reusable suits must be cleaned of adhesive asbestos-containing dust by vacuuming before surrendering for washing.

5.2 Reprocessing and Recycling

In addition to the general protection measures referred to in point 4 of this TRGS, the following measures must be taken according to the hazard level.

5.2.1 Information Procurement

- (1) Prior to commencing activities, information must be obtained from the supplier, as to whether asbestos was detected in the supplied material or whether the material consists of a rock, which should be considered to be potentially asbestos-containing in accordance with Annex 1.
- (2) If no information or investigation results are available on this, it is necessary to proceed as though asbestos had been detected in the delivered material.

5.2.2 Recycling Plants

- (1) All protective measures and safeguards, which must be deployed for the preparation of asbestos-containing mineral raw materials and their further processing, to ensure the protection of staff in the exercise of their duties, apply equally to stationary-powered equipment for reprocessing and recycling (see point 5.1).
- (2) For mobile-powered equipment for reprocessing and recycling asbestos-containing materials the protective measures and safeguards in point 5.1 apply in so far, as they are applicable and suitable at reasonable discretion to ensure the protection of staff in their activities. The relevant measures must be determined on a risk basis in individual cases.
- (3) Reclaimed asphalt with intentionally added chrysotile must not be reused and must be disposed of in accordance with waste law provisions.

5.3 Processing of Natural Stone

- (1) Natural stone with names such as soapstone, steatite, soapstone, serpentine and "Tauern rock" may contain asbestos.
- (2) In addition to the general protection measures in point 4 of this TRGS, the following measures must be taken according to the hazard.

5.3.1 Cleaning of Surfaces

Loose adherent coatings on raw stones may not be removed with liquid jet cleaners. Instead, these coverings must be carefully mechanically removed after sufficient pre-wetting with water or extracted with an industrial vacuum cleaner of category H [15].

5.3.2 Mechanical Processing

- (1) Wet machining processes are preferable to dry machining processes.
- (2) Dry machining of workpieces is permitted only where there is extraction of the resulting dust.
- (3) Only hand tools with dust extraction may be used (e.g., drills, grinders, cutting grinders). Slow running machines are preferable in this case.
- (4) The industrial vacuum cleaners and dust extractors used must be executed in category H [15].
- (5) If the use of extracted hand tools is not possible, processing should only be performed while using breathing apparatus and protective work clothing.

5.3.3 Cleaning the Work Area

Floors must be regularly moistened to clean them or vacuumed with an industrial vacuum cleaner of category H.

5.4 Release and Lubricant Materials

Before commencing activities, information about the asbestos content of the materials delivered must be obtained. This information is usually included in the safety data sheet and/or product data sheet of the manufacturer or supplier. In addition to the general protection measures referred to in point 4 of this TRGS, the following measures must be taken according to the hazard level.

5.4.1 Storage and Material Transport

- (1) Talc-containing containers must be kept dry and protected from humidity (risk of slipping).
- (2) Talc-containing containers must be stored, so as to avoid a release of dust. Material spilled from damaged containers must be captured with appropriate cleaners. Returning material that has leaked out is not permitted on principle.
- (3) Opening closed containers in storage is not permitted on principle. The containers must be stored, so that no damage to the containers may occur.
- (4) The material transport of talcum powder to the processing and use area must use dust-free, sealed containers.

5.4.2 Use in the Work Area

- (1) Only the quantity required to carry out the work may be available in the workspace. The vessel already provided for other activities or containers must be placed so that an accidental release of talcum powder is avoided.
- (2) Manual filling and refilling of containers is carried out so that any release of dust is kept to a minimum. Appropriate measures are:
 1. Vacuum provision in a filling area for a mixing station,
 2. A low filling height or drop height when adding or dosing,
 3. Extraction at the mixing station
 4. Removal of spilled material (see point 5.4.3).
- (3) The manual powdering must be carried out so that a release of dust is kept to a minimum. Appropriate measures are:
 1. Preparing the powder in close proximity to the place of use,
 2. Applying the powder with tools that ensure a low-dust working process; cloths or brushes are suitable
 3. Extraction of scattered residue.
- (4) Machinery and equipment shall be selected and operated so that as little dust as possible is emitted. Dust-emitting process steps, such as applying talcum powder or talc-containing products during the extrusion of rubber or silicone-rubbers, must be effectively extracted, as far as this is possible at the state of the art and the dust release is not prevented by other procedural measures (closed system).
- (5) For these activities, appropriate particle-filtering respiratory protective devices referred to in point 4.14 must be worn when the general dust limit value can be adhered to with certainty.

5.4.3 Cleaning of the Equipment

- (1) Dust build-up should be avoided. If this is not possible, work spaces, roadways and equipment must be cleaned regularly. The cleaning intervals must be set according to the amount of dust deposited in the working area.
- (2) The cleaning is carried out so that the release and dispersion of dust is kept to a minimum. The cleaning must be carried out with the appropriate industrial cleaners of category H [15].
- (3) Manual cleaning of floor coverings with water should be avoided, because the flooring, due to the product characteristics of talcum powder or talc-containing products, becomes extremely smooth.

5.5 Fillers and Aggregates

In addition to the general protection measures referred to in point 4, the following measures must be taken according to the hazard level:

1. Filling and aggregate of grain size 0-2 mm should be stored in sealed silos.
2. Fillers and aggregates over 2 mm should be stored in material boxes sealed on at least 3 sides.
3. When adding fillers and aggregates to the production process and in the stock transfer, the release of dust must be minimized at the state of the art.

5.6 Tunneling

In addition to the general protection measures referred to in point 4 the following measures must be taken according to the hazard level.

5.6.1 Preferential measures of the customer during the planning phase

5.6.1.1 Geological survey

An assessment of the surrounding rock in terms of asbestos should be carried out in advance. If asbestos is suspected, a geological survey should be carried out. The potential hazard must be described in the geological opinion.

5.6.1.2 Customer risk analysis

(1) If there is the possibility that asbestos-containing rocks will be encountered when driving the tunnel, a risk assessment must be created, in particular with regard to exposure to asbestos. On the basis of this determination, in the course of the design planning a safety and health and safety design must then be compiled, taking into account the following two risk classes, with the attendant protective measures and notified to the competent supervisory authority.

(2) The following two risk classes must be determined:

1. No hazard should be expected due to asbestos fibers,
2. A possible exposure to asbestos fibers in the air is to be expected.

5.6.1.3 Selection of the Excavation Procedure

When tunneling in rocks containing asbestos the excavation procedure should be selected, which produces only the lowest dust formation possible.

5.6.1.4 Classification of the Rock

If the asbestos content in the surrounding rock is greater than 0.008 % by mass, the nature and extent of the metrological surveillance and protective measures must be recommended. The certificate should be created as per Annex 2, Process 4.

5.6.1.5 Respiratory Protection

The customer must determine on the basis of the geological preliminary exploration which respiratory protection should be provided, if asbestos was detected in the sampling (see point 3.2.2). The type of respiratory protection depends on the extraction and precautionary measures for the expected asbestos fiber concentration and should be determined in accordance with point 4.14.

5.6.2 Measures in the Tender and Execution

The following measures must be described in the invitation to tender by the contracting authority in detail. The contractor must plan these in detail according to its actual construction process and implement them. This must be reviewed by the contractor to check whether these measures are sufficient.

5.6.2.1 Geological Monitoring of the Advance

If the possibility exists that asbestos occurs in the rock, the penetrated rock should be monitored at least once per shift, in case of blasting after every firing, by a competent person (such as a geologist, mineralogist) for asbestos. The open face and soffit must be documented in regard to the geology encountered.

5.6.2.2 Technical and organizational protective measures when asbestos dusts occur in the tunnel before driving.

5.6.2.2.1 Black and White Area

The contaminated area (black area) must be demarcated from the white area using suitable measures.

5.6.2.2.2 Locks

At the transition between the black and white area, person locks and vehicle cleansing facilities must be constructed, which are supervised the by lock attendant.

5.6.2.2.3 The following requirements apply driver and control cabins:

1. Driver and control cabins in dumpers, loaders and the cement mixers from external suppliers of concrete must be equipped with a system for supplying breathing air according to the state of the art in accordance with BGI 581 for work in the black area. Because the hazard is posed by dust, the corresponding filter equipment must be selected. The filter must be suitable for operation at high air humidity.
2. Clear signposting for persons outside must be ensured (for example by affixing signs and signals).

3. The vehicles may be entered and exited only in the white area after the drive-through and cleaning vehicle lock.
4. The opening of doors and windows in the black area is permitted only in case of emergency. Personal protective equipment must be carried for emergencies, so that the vehicle can be left. The interior must then be decontaminated before reuse.

5.6.2.2.4 Ventilation

The air must be extracted and then be cleaned of dust in the working face area. Fresh air must be fed in, so that dust circulation is avoided as far as possible. A total ventilation design must be created and updated.

5.6.2.2.5 Minimization of Asbestos-Containing Dust

Asbestos-containing dust must be bound using appropriate measures or precipitated and minimized as a result. This is possible through the following measures:

1. Wetting of the excavation areas with water,
2. Keeping the excavated material and the roadway in the black area moist,
3. Drilling using a wet or injection procedure,
4. Jetting or water sprinkling or dust removal on conveyor belt transfer points and encapsulation of conveyor belt equipment,
5. No intermediate storage of excavated material in the tunnel.

5.6.2.2.6 Cleaning of Vehicles and Equipment

The vehicles and equipment must be wet cleaned. A special industrial vacuum cleaner of dust class H [15] should be used to clean the operating cabins.

5.6.2.2.7 Maintenance Work

When removing the air filter on vehicles and equipment (wheel loaders, dumpers, cement mixers, drilling unit), which are used in the black area and during cleaning and maintenance of dust collection systems, special protective measures, such as e.g. air extraction facilities, are required at the places of work.

5.6.2.2.8 Finishing Works

After tunneling through the asbestos-containing layers of rock, a tunnel cleaning, a clean-up of contaminated work equipment and other construction site equipment must be performed. The cleaning must be performed to achieve an asbestos fiber concentration of less than 10,000 F/m³.

5.6.2.2.9 Safety Markings

Safety signs must be fitted to delimit the hazardous area.

5.6.2.3 Personal Protective Equipment

(1) This includes, among other things:

1. Filter units with fan support in the helmet, as well as half masks with an FFP2 filter with an exhalation valve, where this is sufficient, otherwise at more than 100,000 F/m³ an FFP3 filter and from 300,000 F/m³ masks with blowers and a TM3P particulate filter.
2. Disposable protective suits of category III type 5 that are as breathable as possible and moisture access type 6 or otherwise, at more than 100,000 F/m³ – type 4.

(2) The particulate filter and the protective suits should be changed whenever leaving the black area.

(3) When working with fan-supported breathing apparatus, a personal device must be provided specifically for each employee who is in the black area.

5.6.2.4 Sampling and Analysis

5.6.2.4.1 Measuring Program

Establishing a measurement program accompanying the construction project, as well as accompanying measurements of other mineral fibers, coordinated with the overall geological conditions.

5.6.2.4.2 Measuring Location

A measuring site must be selected, where very high asbestos concentrations are expected (such as a debris area).

5.6.2.4.3 Measurements

Measurements of asbestos fiber concentrations in the breathing air must be commenced when asbestos-containing rocks are expected in the excavation. The measurements can be ceased if no further asbestos-containing rock is expected and the tunnel is cleaned.

5.6.2.4.4 Sampling Systems

The measurements should be performed with fixed sample systems separately performed for the various work steps, in order to be able to use targeted technical improvement measures. Staff-worn sampling systems are used where the exposure to asbestos of employees at the workplace should be determined.

5.6.2.4.5 Evaluation of the Measurements

The concentration measurements must be evaluated as soon as possible to be able to review and, where necessary, adjust the necessary protective measures in the short term.

5.6.2.5 Organization of Work on the Construction Site

In the black area, the maximum working time is 8 hours/day and a maximum of 40 hours/week.

5.7 Cold Milling of Road Surfaces

In addition to the general protection measures in point 4 of this TRGS, the following measures must be taken according to the hazard.

5.7.1 Investigation and Information Requirements

5.7.1.1 General

(1) The site manager or customer must, due to their obligations under § 15 paragraph 1 sentence 2 of the GefStoffV, § 2 paragraphs 1 and 3 in conjunction with § 4 of the Baustellenverordnung/Construction Site Ordinance [16] and, where appropriate, other legislation determine whether asbestos can be included in the material to be milled.

(2) According to the result of the investigation, the potential hazard must be described by the site manager or customer. In case of justified suspicion of asbestos immediate protective measures must be determined as per point 5.7.2, in particular road milling shall be implemented as per 5.7.2.1 paragraph 2 or where there is reasonable suspicion for its removal due to a preliminary exploration.

(3) To ensure a proper implementation of the construction works, the site manager or customer should present the results of the investigation referred to in paragraph 1 in the tender documents.

(4) If the investigations referred to in paragraph 1 do not exist, the employer must, in accordance with § 6 in conjunction with § 15 paragraph 4 GefStoffV, when gathering information, obtain in particular from the site manager or customer information about whether asbestos fibers can be released in the works to be carried out.

5.7.1.2 Prior Investigation

If a prior investigation is carried out, this can take place

1. on the basis of the building documentation available public road authorities, if the nature or origin of the rock used must be determined in these documents. In this case, based on the information on potentially asbestos-containing rock types from Annex 1, tests can be performed to determine whether the release of asbestos fibers should be expected in the milling works, or

2. on the basis of material samples (e.g. cores) from the surface sealing, which are being tested for asbestos. A representative material sample should be taken for each 6,000 m² of surface to be milled² and tested for asbestos. Where the sealing of the surface being milled was manufactured from the same mineral substances as a sample point and test results showed no asbestos, this can be omitted from further investigation. Otherwise, sampling must include all different surfaces encountered.

5.7.2 Measures in the Tender and Execution

- (1) If the preliminary exploration and assessment referred to in point 5.7.1.1 revealed that the material to be milled contains asbestos, protective measures must be provided by the client in the tender items.
- (2) The contractor must plan these in detail according to its actual construction process and implement them. This must be reviewed by the contractor when creating the risk assessment to check whether these measures are sufficient.
- (3) Not only employees directly involved in the milling works need to be considered when determining the protective measures. Those employed in the wider area and in activities in the wake of the milling (such as sweeping work, material transport) must be included.

5.7.2.1 Measures to Reduce Exposure

- (1) As far as the complete capture of accumulated asbestos dust through the use of suitable road milling or milling process is not guaranteed, measures must be taken to minimize exposure.
- (2) Primarily road milling machinery must be selected and operated with which workers are exposed to an asbestos fiber concentration of under 10,000 F/m³. This is, for example, guaranteed by using milling machinery that complies with the recommendations of BGI 790-020 [18].
- (3) As long as road milling machinery as per point 5.7.2.1 paragraph 2 is not available or not used, minimization of exposure to asbestos fibers must be implemented according to the current state of the art. The selection of the measures or which of the measures in combination are to be applied, is the duty of the employer on the basis of its risk assessment. Appropriate measures are, for example:
 1. When milling, precipitating any dust created by water wetting, the operator keeping the water system on the milling machine in good working condition, dry milling is fundamentally not permitted.
 2. Enclosing the milling roller and conveyor equipment, keeping the enclosure for the operator in good working condition.
 3. Equipping conveyor belt transfer points with a water sprinkler system or jet,

² The sampling is carried out in accordance with the specifications in the ZTV-Asphalt-StB (Zusätzlichen Technischen Vertragsbedingungen und Richtlinien für den Bau von Fahrbahndecken aus Asphalt/[Supplementary Technical Conditions for Contracts, Specifications, and Guidelines for Road Construction using Asphalt]) 07, Edition 2007, from the Research Association for Roads and Traffic (FGSV) Cologne [17].

attaching a water sprinkler system or jet at the belt dropping point.

4. Minimizing dust formation while loading on vehicles by adjusting the discharge height to the height of the lifter.
5. Wet cleaning machinery and machine parts.
6. Equipping vehicles for the removal of milling material with enclosed cabins, air conditioning and dust filtering, during operation keeping windows and doors closed, driver cabs must be cleaned regularly.

For protective measures which may be necessary in the use of road milling under point 5.7.2.1 paragraph 2, refer to the respective operating instructions of the machinery.

- (4) More appropriate measures to minimize dust exposure are, for example, example:
 1. Minimizing dust released at the origin point (milling roller housing) by using effective dust reduction (for example, extraction).
 2. Equipping conveyor belt transfer points with effective dust reduction (e.g. extraction).
 3. Feeding extracted air to a dust removal system with a sufficient degree of separation. The asbestos fiber concentration in the exhaust gas of the collector may not exceed, pursuant to TA Luft [14], 10,000 F/m³.
 4. Equipping milling machines with cabins with an enclosed design, with air conditioning and dust filters, during operation keeping windows and doors closed, driver cabs must be cleaned regularly.

The selection of measures, or which of the measures in this paragraph should be applied in combination, is the duty of the employer on the basis of their risk assessment with the aim being not to exceed 10,000 F/m³.

5.7.2.2 Social Facilities

- (1) At the work site at least one wash-basin and the option of separate storage for working or protective clothing on one side and street clothing on the other side must be available.
- (2) Meals may be taken only in areas, where is the asbestos concentration is below 10,000 F/m³.

5.7.2.3 Personal Protective Equipment

- (1) Personal protective equipment must be used by the milling machine operator and by the deployed ground staff, if it is not guaranteed that the asbestos fiber concentration is less than 10,000 F/m³.
- (2) The wearing of protective equipment can be omitted if road milling or the milling process is implemented as per point 5.7.2.1 paragraph 2.

5.7.2.3.1 Protective Clothing

- (1) Single-use or reusable suits must be used as protective clothing.
- (2) After leaving areas where there is exposure to asbestos, protective clothing must be cleaned (e.g. by suction) and must be removed before taking off respiratory protection.

5.7.2.3.2 Respiratory Protection

Respiratory protection must satisfy the requirements of point 4.14 paragraph 2. Furthermore, respiratory protection hoods or helmets can be worn with a TH2P particle filter. Preferably, fan-assisted respiratory protection is to be used.

6 Occupational Health Prevention

6.1 Participation of the Occupational Physician in the Risk Assessment

In the case of activities with potentially asbestos-containing mineral raw materials and mixtures and products derived therefrom, occupational medicine prevention generally comprises the participation of the occupational physician in the risk assessment, general medical advice and occupational health care. The focus here is on imparting knowledge about the carcinogenic and other chronically damaging properties, as well as the burden of wearing personal protective equipment. The workload must be included in the assessment of the inhalation burden.

6.2 Occupational Medicine-Toxicological Advice

- (1) The goal of the occupational medicine toxicological advice is to inform endangered employees, for example, within the framework of a briefing. The instruction is to be provided as far as possible with the participation of the company's physician and is also intended to provide information on the uses and scope of occupational health care examinations and to motivate them to participate.
- (2) Within the framework of the general occupational health toxicological advisory for activities with potentially asbestos-containing mineral raw materials and mixtures and products derived therefrom, it should be pointed out, among other things, that
 1. diseases caused by inorganic dusts such as asbestos under certain conditions can be recognized as an occupational disease. Specifically, the occupational diseases asbestos dust pneumopathy (asbestosis), lung cancer or laryngeal cancer in connection with asbestos dust pneumopathy (asbestosis), as well as "mesothelioma caused by asbestos in the pleura, the peritoneum or the pericardium" play a role,
 2. the main cause is inhalation of asbestos-containing dust via the respiratory tract and after a latency of approximately 20-30 years major damage to the respiratory organs and cancers may result. (Both lung cancer and cancer of the larynx can result from exposure to asbestos. A significant further typical tumor type, which is linked to asbestos, is mesothelioma. Mesothelioma is a malignant tumor of the pleura, the peritoneum or the pericardium. An increase in the intake dose of asbestos fibers

tends to increase the risk of cancer development. Malignant mesothelioma has a poor prognosis.),

3. continued inhaled cigarette smoking increases the adverse effect of asbestos dust massively, especially the development of lung cancer, laryngeal cancer, mesothelioma and chronic respiratory tract infections, because the self cleaning mechanism of the lung is disturbed continuously,
4. the interaction of asbestos dust, and polycyclic aromatic hydrocarbons or ionizing radiation increases the risk of cancer in the lung area,
5. a respirable and alveoli-permeable asbestos dust, depending on the dose, can lead to permanent damage to the bronchii and lungs with chronic airway inflammation and a measurable reduction in lung function, as well as permanent lung tissue restructuring, which can progress even without continued exposure and is barely affected by medical procedures,
6. the implementation of the protective measures set out in the operating instructions, including personal protective equipment and occupational hygiene, which can significantly reduce health risks.

6.3 Occupational Health Care

(1) Occupational health care is governed by the Verordnung zur arbeitsmedizinischen Vorsorge/[Regulation on Occupational Health Care] (ArbMedVV) and the Arbeitsmedizinischen Regeln/[Occupational Health Rules] (AMR) published with them.

(2) Occupational health care is assessing the individual interrelation between work and physical and mental health and early detection of work-related health problems, as well as determining, whether there is an increased health risk in the exercise of a particular activity (§ 2 paragraph 1 number 2 ArbMedVV). In this case advice for employees on exposure and the hazards resulting from it for their health is the focus. If physical or clinical investigation from the perspective of the physician for education and advice are not required or are rejected by the worker, the occupational health care is confined to a consultation (§ 2 paragraph 1 number 3 ArbMedVV). Prior to commissioning radiographic examinations, it is important to critically evaluate the supporting indication according to the Röntgenverordnung/[German X-Ray Regulation].

(3) Occupational health care must be arranged for the workers concerned according to § 4 paragraph 1 in conjunction with Annex Part 1 paragraph 1 point 1(a) ArbMedVV by the employer prior to the activity and then at regular intervals (cf. AMR 2.1) (mandatory care), when repeated exposure to asbestos in the workplace cannot be ruled out. The employer may allow only the task to be performed by the workers concerned, if they have participated in the mandatory care beforehand (§ 4 paragraph 2 ArbMedVV).

(4) Occupational health care must be offered to the workers concerned under § 5 paragraph 1 in connection with Annex Part 1 paragraph 2 number 1 ArbMedVV by the employer prior to the activity and then at regular intervals (see AMR 2.1) (offer care), if it has no mandatory care to provide and exposure to asbestos cannot be ruled out. The rejection of an offer does not release the employer from the obligation to further regularly offer care. AMR 5.1 shows one form of offer submission.

(5) Where the affected workers must wear respirators, the obligation care or offer care for this purpose (Annex Part 4 paragraph 1 number 1 or paragraph 2 number 2 ArbMedVV) should be combined due to asbestos.

(6) After termination of the activity involving exposure to asbestos, the employer must offer affected employees according to § 5 paragraph 3 sentence 1 in conjunction with Annex Part 1 paragraph 3 number 1(a) ArbMedVV follow-up care at regular intervals (cf. AMR 2.1). The offer of occupational health care then provides early detection of asbestos-related illnesses. Health problems due to asbestos exposure can be expected especially after long latency periods. Declining an offer does not release the employer from the obligation to further regularly offer care in the form of follow-up care. AMR 5.1 shows one form of offer submission. Provided that the employees have consented, at the end of the employment relationship the employer transfers the obligation to offer follow-up care to the competent statutory accident insurance institutions and provides this with a copy of the required documents (cf. § 5 paragraph 3 sentence 2 ArbMedVV).

(7) According to § 6 paragraph 3 ArbMedVV, the physician retains the result and findings of the occupational health care, including where applicable any examination carried out, in writing and advises the employees of this. Upon request by an employee they will make the result of this care available. The doctor provides the employee and the employer with a certificate for the occupational health care provided. The certificate must contain information on the time and reason for the current care appointment, as well as information regarding when further occupational health care is indicated from a medical perspective (cf. AMR 6.3). The certificate must contain neither diagnoses or any other information about the health condition of the employee nor a medical assessment on their suitability for certain activities.

(8) According to § 3 paragraph 4 ArbMedVV, the employer must maintain a care register regarding the occupational health care provided, with information about when and on what occasions this has occurred for each employee.

(9) According to § 6 paragraph 4 ArbMedVV, the physician evaluates the findings of the occupational health care. If there is evidence that occupational health and safety measures are not sufficient, the doctor must inform the employer of this and suggest (complementary) protective measures for exposed workers. This is done as a professionally commented and anonymized delivery of findings from the occupational health care, while respecting the interests of the people studied that justify protection. If the doctor for medical reasons, which are only in the person of an employee, considers a change of activity necessary, the communication about this to the employer requires the consent of the employee. AMR 6.4 contains the specifications. The employer must, as the result of a recommendation by the physician under § 8 paragraph 1 ArbMedVV, review the risk assessment and immediately take the measures necessary for protecting the workforce. If a change in activities is recommended, the employer must in accordance with the employment and labor regulations assign the employee to another activity.

Literature

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- [10] VDI Guidelines 2262: Air quality in the workplace; Reduction of exposure to air pollutants, Sheet 1: General Requirements, Sheet 3: Ventilation Measures
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Further literature:

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2. Diagnosis and assessment of asbestos-related illnesses, Interdisciplinary S2-Guidelines from the German Society for Occupational and Environmental Medicine and the German Society for Pneumology and Respiratory Medicine; <http://www.awmf.org>

Annex 1 to TRGS 517**Discovery of Rock Deposits Containing Asbestos**

(1) In the mineral deposits found when mining in the Federal Republic of Germany, for particular types of rock the occurrence of the asbestos minerals, chrysotile, tremolite, actinolite and to a lesser extent also anthophyllite needs to be taken into account. Above all, basic magmatites are effected. The asbestos minerals are formed only after the mineral formation by chemical conversion of primary minerals in the rocks or crevices. As these processes are dependent on particular mineral-chemical requirements, the occurrence of asbestos minerals is limited to particular rock types, but does not necessarily occur in those.

(2) The following rock types should in particular be considered to be asbestos-containing:

- Ultrabasite/peridotite (e.g. dunite, lherzolite, harzburgite),
- Basic effusives (e.g. basalt, spilite, basanite, tephrite, phonolite),
- Basic intrusives (e.g. gabbro, norite, diabase),
- Metamorphic and metasomatically influenced rocks (e.g. metasomatic talc occurrences, green schist, chlorite and amphibole schist/bedrock (e.g.: nephrite), serpentinite, amphibolite).

(3) The list is very general. In special geological circumstances in individual cases other rocks can occur, which can possibly contain asbestos. These have, however, little relevance to the mineral deposits mined in the Federal Republic of Germany. It should be noted that alongside the mineral names found in the usual nomenclature (following Streckeisen), local or old rock names are also often used.

(4) Above all for names for igneous rocks the metamorphic transformations, which are important for the existence of asbestos minerals, are often disregarded. That means that, e.g. a gabbro or diabase with an unchanged existing mineral content contains no asbestos minerals. If this rock has, however, been subjected to metamorphosis or hydrothermal influences, the occurrence of asbestos is possible. The mineral terms gabbro and diabase are, as a rule, however, used again for these altered rocks. An initial assessment is made still more difficult by the fact that for some rock designations, e.g. diabase, various definitions exist.

(5) When identifying a potentially asbestos-containing rock, in individual cases a petrographic characterization of the mineral deposit is necessary, which is based on the current classification. Corresponding mappings of mineral deposits have frequently already been conducted previously, e.g. during mapping by the state geological institution or as part of a research project by a mineralogical/geological institution. If this is not the case, the employer must establish in a mineralogical/geological assessment the petrographic characterization of the mineral deposition.

(6) Asbestos or asbestos minerals (fibrous and non-fibrous) can occur in the rockformation in two distinct forms:

- Asbestos/asbestos minerals in crevices,
- Asbestos/asbestos minerals in "compact" undisturbed rocks.

(7) The first form of occurrence is easy to recognize in quarry inspections. The asbestos minerals contained in the rock itself can, as a rule, only be identified by petrographic studies. Frequently the Asbestos fibers "come about" in the second form mentioned only due to mechanical loads on the rock (processing) from non-fibrous asbestos minerals.

Annex 2 to TRGS 517**Procedure for Determining the Mass Content of Asbestos Technique**

- (1) In procedures 1 to 4 of this Annex the analytical processes are described, which are suitable depending on the nature of the materials when determining the mass content of asbestos in accordance with Annex II No. 1 of the Hazardous Substances Ordinance.
- (2) Generally, it is necessary to bear in mind that mineral resources are subject to certain fluctuations in their mineralogical composition. This can be both in the non-homogeneity of mineral raw materials, as well as in the fact that in advanced mining of a deposit or alternating use of materials from various areas of occurrence, materials of a different mineralogical composition are distributed under a single product name.
- (3) According to the processes listed in Processes least 1 to 4 in this annex, at least three determinations of the percentages by mass of asbestos in a material should be carried out at least 30 days apart. To comply with the requirements of Annex II No. 1 of the Hazardous Substances Ordinance none of the results may exceed the value of 0.1 % by mass. If the three results identified clearly differ from each other, it should be clarified at the deposit site, whether there might be asbestos-containing fracture fillings (see also Annex 1).
- (4) In the study of mineral raw materials already put in place (e.g. chippings in road surfaces when preparing for milling) the number of samples must be selected so that the area affected by the work or the amount of material provided for reprocessing is sampled representatively. However, at least three tests are required. The time interval of 30 days for conducting the sampling does not apply in this case.
- (5) If it is possible to carry out the determination of the percentages by mass of asbestos in the area of recycling or reprocessing, Procedure 2 should be applied.
- (6) In addition to asbestos fibers, a range of other, similar minerals to the asbestos minerals occur in mineral raw materials, which can complicate an unambiguous identification of asbestos fibers. To ensure a consistent approach from different analytical laboratories and thus comparable results, when applying the above mentioned analytical methods the supplementary criteria for identifying fibers [3] should be used.
- (7) When processing asbestos-containing products, respirable asbestos fibers are released, which predominantly display a length-to-diameter ratio of $> 10:1$ and mostly exhibit a small diameter ($< 1 \mu\text{m}$). The asbestos fibers released in the processing of mineral raw materials clearly differ from these morphologically. The majority of these particles have a length to-diameter ratio of $< 5:1$ and usually a larger diameter. The calculated mass percentage of asbestos consists therefore in asbestos-containing products usually of a large number of long thin fibers and in mineral raw materials of a comparatively smaller number of shorter thicker fibers. To estimate the potential of exposure to asbestos, in addition to the determination of the mass percentage of asbestos, the number of asbestos fibers per mg of material examined should also be determined. This information is gathered when determining the mass percentage.

Process 1: The determination of the percentages by mass of asbestos in powder-form material (e.g. rock flour, talcum powder, filter dust)

- (1) This process should be applied when the material already exists in powder form. A large part of the material should display particle sizes $< 100 \mu\text{m}$. This fraction corresponds approximately to the respirable dust fraction.
- (2) The description of the analysis method can be found in [19]. For the evaluation ensure that only those fibers are considered in the evaluation with a length $> 5 \mu\text{m}$, a diameter $< 3 \mu\text{m}$ and a length-to-diameter ratio $> 3:1$.
- (3) Asbestos bulk content determined according to [19] reflects the mass content of asbestos in the powdery material.

Process 2: The determination of the mass content of asbestos in the material in the processing area (e.g. into gravel and grits) or reprocessing (e.g. when milling road surfaces)

- (1) This process can be applied, if it is possible to carry out a dust sampling during the treatment or recycling of the material. To do so, E-dust measurements should be carried out under "worst case" conditions (in the dust cloud on the lee side near to the dust source) in especially dust-intensive operations, such as in a screening plant or in the open storage (unloading, loading). A membrane filter should be used for sampling (no fiber materials). The duration of the sampling must be long enough to be a representative sample for a large amount of processed material and on the other hand, to collect enough dust on the filter. The mass of the dust must be determined. A defined amount is taken from the dust. On the basis of this, the percentage by mass of asbestos is determined according to [19]. For the evaluation ensure that only those fibers are considered in the evaluation with a length $> 5 \mu\text{m}$, a diameter $< 3 \mu\text{m}$ and a length-to-diameter ratio $> 3:1$.
- (2) The asbestos bulk content determined by [19] does not reflect the bulk content of asbestos in the examined material, as only a small proportion of the processed material was released as dust. Under conservative assumptions, it is assumed that not more than 1 % by mass of the material is crushed into a respirable dust. To determine the percentages by mass of asbestos in the material it is therefore necessary to divide the analysis results for the dust being analyzed by 100.

Process 3: The determination of the mass content of asbestos in fine-grained or broken products (e.g. crushed sand, double-crushed chippings)

- (1) This process should be applied when there is a prepared granular product with a grain size of up to 20 mm at maximum. Typically these are crushed sands, double-crushed chips and other fine-grained chippings used in construction. These also include recycled construction materials of the corresponding grain size.
- (2) The dust-forming nature of powdery bulk materials is studied using CDD dusting apparatus according to DIN EN 15051 – Method B [20, 21]. In addition, dust formation processes are simulated, which involve continuous deposition (conveying, delivery, filling,

refilling, weighing, bagging, dispensing, loading and unloading, tipping and pouring) and in which a release of dust occurs to do separation during the falling process and resuspension on impact.

(3) The test material is delivered from the sample container by a dosing channel in a drop tube, which has air flow through it in the opposite direction with a total air volume of 53.0 l/min. (an air speed of 0.05 m/s at a diameter of 150 mm).

(4) For each test run three samplings are carried out with different measurement durations in the downpipe, in order to obtain one suitable impact strength for analysis with the scanning electron microscope (SEM). The measurements are taken using branch current drain with the BGIA measuring head FAP for fiber measurements, which is equipped with a gold-sputtered nuclear pore filter (pore diameter 0.4 µm) with a 37 mm diameter. The filter will be weighed before the measurement. The test volume flow is 2.0 l/min.

(5) The number of asbestos fibers with the dimensions according to the WHO and the dust released from the asbestos mass are determined, as well as the mass percentage of asbestos based on the filter assignment are calculated by back weighing by means of scanning electron microscopy.

(6) After conversion to the full flow using the factor 26.5, the mass content of the asbestos fibers (total mass content of the fibrous and non-fibrous components of the asbestos minerals) can thus be determined relative to the drop weight, i.e. the mass content of asbestos in the ready-to-use product. The conversion factor of 26.5 is calculated as a quotient from the total volume flow of 53.0 l/min and the sample flow volume of 2.0 l/min.

(7) The determination of the mass content of asbestos can be made using a dust sample from the E-fraction during the dusting test. From the filter struck by the dust a partial quantity can be captured and transferred to a suspension. From that point, a defined amount is then filtrated onto a gold-sputtered pore filter, which is evaluated using SEM/EDXA (detailed information on the procedure during preparation can be found in [19]).

(8) To determine the mass content of asbestos the process under [19] should be applied. For the evaluation, be aware that only those fibers should be considered in the evaluation with a length > 5 µm, diameter < 3 µm and a length-to-diameter ratio > 3:1.

(9) The mass content of asbestos determined by one of the two methods gives the Mass content of asbestos in the material analyzed.

Process 4: The determination of the mass content of asbestos in compact materials (e.g. soapstone pieces, natural stone), the use of which can result in respirable dusts (e.g. by drilling, sawing, milling, grinding)

(1) Before the analysis the material must be crushed. The material is then pre-crushed by breaking or in a mortar. A representative amount is taken from the crushed material for grinding in turn. The grinding has to ensure that the particle size of the milled material is < 100 µm. This fraction corresponds approximately to the respirable dust fraction. A description of the following analytical process may be found in [19]. For the evaluation, be aware that only those fibers should be considered in the evaluation with a length > 5 µm, diameter < 3 µm and a length-to-diameter ratio > 3:1.

(2) Asbestos bulk content determined according to [19] reflects the mass content of asbestos in the powdery material. Therefore, the analysis process delivers results for the "worst case" scenario.

(3) For certain applications (e.g. analysis of cores or milling material from road surfaces), this method is used only to detect the presence of asbestos in the sense of point 3.2.3. The comparison of the determined values for such mass content determinations with the value determined in the Hazardous Substances Ordinance in Annex II No. 1 paragraph 2 of 0.1% is not then permitted. Process 2 for mass content determination given in Annex 2 of this TRGS is used for this purpose.

Annex 3 to TRGS 517**Procedures for the identification and assessment of the asbestos fiber exposure**

(1) The level of asbestos fiber exposure is to be determined by workplace measurements as per TRGS 402 [5] together with DIN EN 689 [22]. This is described by the measurement result of the average asbestos fiber concentration for an 8-hour work shift (average shift value).

(2) To determine the asbestos fiber concentration, the electron microscopic process under BGI 505-46 [6] should be applied. As a complementary evaluation criteria to distinguish between asbestos and other similar minerals, consult the instructions referred to in [3].

(3) For the determination of a value lower than the acceptable concentration of 10,000 F/m³, the evaluation criteria in DIN EN 689 [22] should be applied, together with the further requirements given in this annex. According to this, the technical measurement determination of a value lower than 10,000 F/m³ can be demonstrated by satisfying the conditions specified in the following paragraphs 4 to 10.

(4) For all measurement results (ME) in at least three successive measurements ME must be such that

$$ME < \frac{1}{4} \times 10,000 \text{ F/m}^3$$

or the geometric mean of the assessment indices (BI) of the measurement results (ME) of at least three consecutive measurements (BI₁ to BI_n) must be such that

$$\sqrt[n]{(BI_1 \times \dots \times BI_n)} \leq 0,5$$

In this case BI = the measurement result in F/m³ divided by 10,000 F/m³ (the acceptable concentration). Measurement results with a less than sign (<-values), the numerical value of which represents the analytical sensitivity of the method of analysis for the determination of the concentration of asbestos fibers, should be included without the less than sign in the calculation.

(5) Control measurements must be carried out if the risk situation has changed substantially, such as due to a change in the operating conditions (see point 3.3 paragraph 2) or the evaluation is performed according to paragraph 4 on the basis of the geometric mean.

(6) Because the asbestos content in mineral raw materials and the mixtures and products manufactured from them usually varies from measurement to measurement, the value below 10,000 F/m³ through fulfillment of the condition from DIN EN 689 [22], which states that 1 measurement result must be $\leq 1/10 \times 10,000 \text{ F/m}^3$, cannot be reliably demonstrated. This criterion may not be applied here.

(7) "Successive measurements" should be carried out in stationary facilities on various days and in the same working areas, on construction sites for the same activities. When taking the measurements, the boundary conditions according to TRGS 402 [5] must be

recorded.

(8) Conditions of measurement shall be such, that a lower proof limit is reached. The detection limit must not exceed 10,000 F/m³, unless it is to determine a measuring result above 10,000 F/m³.

(9) If the measurements allow no statement about a value lower than 10,000 F/m³, compliance with the acceptable concentration cannot be determined.

(10) While any of the above series of measurements is not completed, or if a measurement the result of a series of measurements exceeds 10,000 F/m³, the value below 10,000 F/m³ cannot be determined.

Annex 4 to TRGS 517

Requirements for the Technical Qualification Referred to in Point 2.11

The technical qualification requirements include:

1. Industry-specific knowledge of the operating procedures,
2. general knowledge on the conduct of risk assessments,
3. Knowledge of the properties and health risks of asbestos,
4. Knowledge of the identification and assessment of potential asbestos-containing materials,
5. Knowledge of the rules and regulations for activities involving asbestos,
6. Knowledge of technical safety, organizational and personal measures.

Experienced professionals in occupational safety in the relevant industry or occupational physicians are preferable as experts, who have the skills specified above.