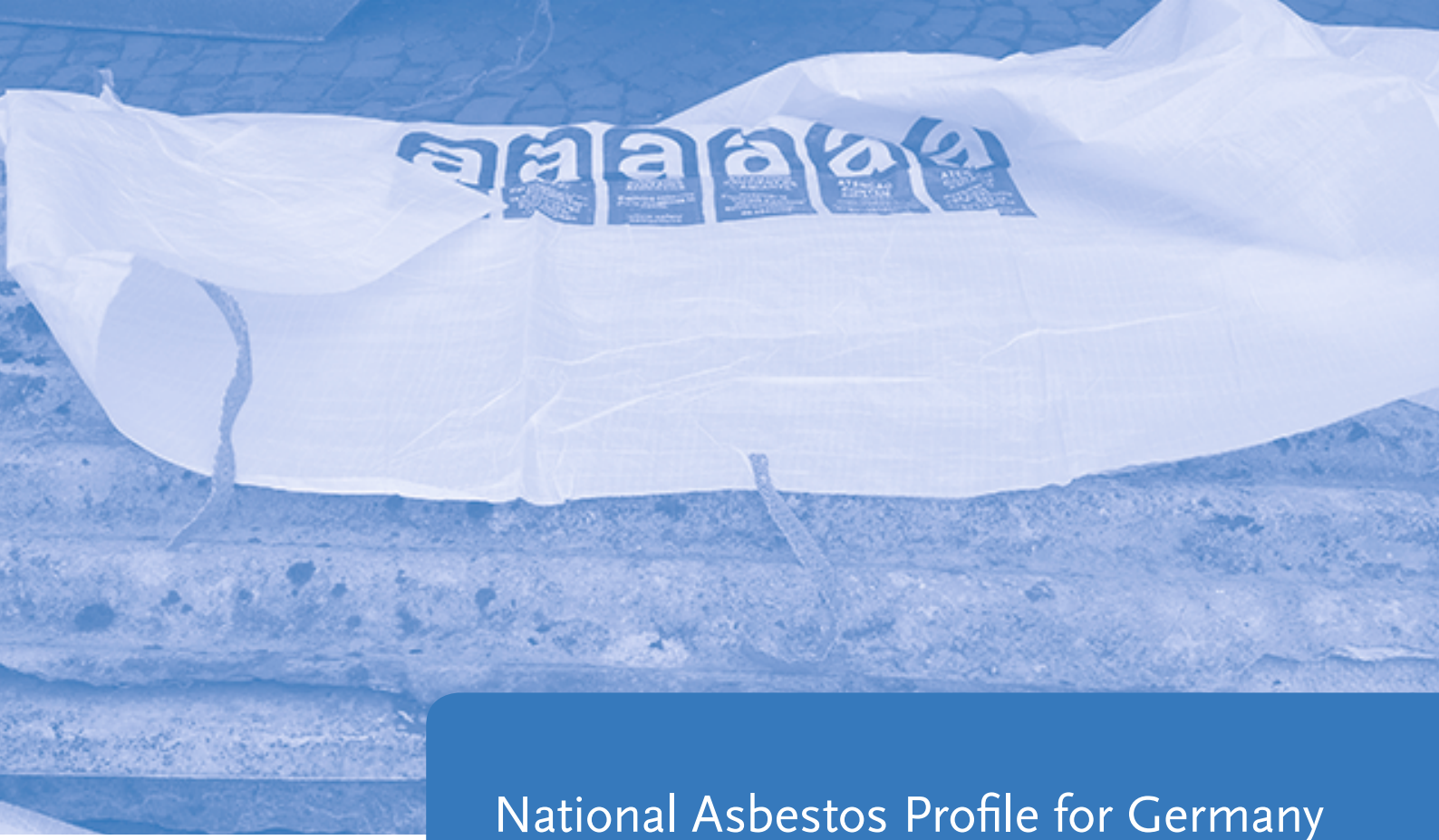

National Asbestos Profile for Germany

baua:
Federal Institute for Occupational Safety and Health

National Asbestos Profile for Germany

Dortmund/Berlin/Dresden 2014

This report is dedicated to Dr. Peter Wardenbach, who recently passed away much too soon. Our colleague Peter was a pioneer in fibre and particle toxicology and always dedicated to improve workers' safety and health.

The preparation of National Asbestos Profiles was initiated by the World Health Organization Regional Office for Europe. The National Asbestos Profiles are part of the development of national programs for the elimination of asbestos-related diseases. The report is based in large parts on data from the German Social Accident Insurance. The Federal Institute for Occupational Safety and Health is particularly indebted to the German Social Accident Insurance for the provision of data and valuable information.
The responsibility for the contents of this publication lies with the authors.

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National Asbestos Profile for Germany

Abstract

At the Fifth Ministerial Conference on Environment and Health held in Parma, Italy, in 2010 the Member States of the WHO European Region adopted a declaration to develop national programmes for the elimination of asbestos-related diseases (ARDs) by 2015 in collaboration with WHO and the International Labour Organization (ILO).
The National Asbestos Profile is an instrument to provide information to the member states. It defines the baseline situation with regards to the elimination of asbestos-related diseases, consumption of the various types of asbestos, populations at risk from current and past exposures. It also determinates the system for inspection and enforcement of exposure limits and the asbestos ban, and the social and economic burden of asbestos-related diseases. The aim of the National Profile is to work as a starting point for development and enforcement of national programs for the elimination of asbestos-related diseases. It shall serve as an instrument to measure the progress made towards the objectives and targets set by the national programs.
The National Profile for Germany follows the reporting structure which was proposed by the WHO for the National Profiles. A comprehensive number of data sources are used. The reporting on asbestos-related diseases is based on data made available by the German Statutory Accident Insurance (recognized cases, new cases, fatalities), by the cause of death statistics of the German Federal Statistical Office and by the German Centre for Cancer Registry Data at the Robert-Koch Institute (RKI). Cost data made available by German Statutory Accident Insurance (DGUV) are used to illustrate the economic burden of asbestos-related diseases. In order to quantify the burden of asbestos-related diseases for society the measurement concept of Disability Adjusted Life Years (DALY) was applied. The DALY measures the years of life lost by asbestos-related diseases in relation to the life expectancy for a specific age group. In order to do this a special evaluation of the occupational disease statistics was conducted by DGUV.
The institution for central registration and medical care agency (GVS) founded by the institutions for statutory accident insurance provides data on registered employees for medical examinations, because of asbestos exposure and registered enterprises currently involved in working tasks with asbestos-containing materials. Data on asbestos containing building materials is derived by evaluation of the hazardous waste disposal statistics of the Federal Statistical Office.
The National Profile differentiates between West-Germany and the former German Democratic Republic (GDR) before German Unification for the case that appropriate figures on asbestos-related occupational diseases and on asbestos consumption and use were available.

Key words:

Asbestosis, Occupational disease, Chrysotile-Asbestos, Disability Adjusted Life Years (DALY), Hazardous Substances Ordinance, Lung cancer, Mesothelioma, Technical Rules for Hazardous Substances

Nationales Asbest-Profil Deutschland

Kurzreferat

Anlässlich der fünften Ministerkonferenz für Umwelt und Gesundheit 2005 wurde von den Mitgliedstaaten der Europäischen Region der Weltgesundheitsorganisation (WHO) eine Deklaration mit dem Ziel der Entwicklung nationaler Programme für die Elimination asbestbedingter Erkrankungen verabschiedet.
Die Nationalen Asbest-Profile haben im Rahmen dieser Programme die Aufgabe über die Asbestsituation im Mitgliedstaat zu informieren. Sie beschreiben den Status Quo bei der Elimination von durch Asbestfasern verursachten Erkrankungen. Die Abbildung des Status Quo bezieht sich auf die Bereiche Asbestverbrauch und -verwendung, die Anzahl der Exponierten, das mit Asbestfasern verbundene Erkrankungsgeschehen, das System zur Überwachung und Durchsetzung von Grenzwerten und Verwendungsverboten sowie die gesellschaftliche und ökonomischen Belastung durch die Erkrankungen. Das Nationale Asbest-Profil soll als erster Schritt auf dem Weg hin zur Entwicklung nationaler Programme für die Elimination asbestbedingter Erkrankungen fungieren und bei der Kontrolle des Erfüllungsgrades der Programmumsetzung unterstützen.
Für den Bericht wurde eine Vielzahl von Datenquellen herangezogen. Für die Berichterstattung zur Entwicklung asbestbedingter Erkrankungen (Altfälle, Neuerkrankungen, Todesfälle) wurde die Berufskrankheiten-Statistik der Deutschen gesetzlichen Unfallversicherung (DGUV), die Todesursachenstatistik des Statischen Bundesamtes sowie Krebsregisterdaten des Robert-Koch-Instituts ausgewertet. Die Darstellung der ökonomischen Belastung durch asbestbedingte Erkrankungen basiert auf Kostendaten zum Berufskrankheiten-Geschehen der DGUV. Die DGUV hat für den Bericht außerdem eine Sonderauswertung der dokumentierten asbestbedingten Todesfälle nach ihrer Altersverteilung vorgenommen. Mit diesen Daten wurde die gesellschaftliche Belastung durch Berechnung der durch asbestbedingte Todesfälle verlorenen Lebensjahre relativ zur statistischen Lebenserwartung geschätzt. Die Gemeinschaftseinrichtung der Gesetzlichen Unfallversicherung zur Gesundheitsvorsorge (GVS) hat Zahlen zu den in der Vergangenheit am Arbeitsplatz mit Asbestfasern exponierten Personen und den aktuell bei Abbruch-, Sanierungs- und Instandhaltungsarbeiten potentiell exponierten Beschäftigten sowie zur Anzahl der mit diesen Arbeiten beauftragten Unternehmen bereitgestellt. Die Mengen der bei diesen Arbeiten anfallenden asbesthaltigen Bauabfälle sowie anderer asbesthaltiger Abfälle wurden der Erhebung über gefährliche Abfälle des Statistischen Bundesamtes entnommen.
Soweit möglich, wurden das asbestbedingte Erkrankungsgeschehen sowie Asbestverbrauch und Asbestverwendung vor der Wiedervereinigung gesondert für die ehemalige DDR dargestellt.

Schlagwörter:

Asbestose, Berufskrankheiten, Chrysotil-Asbest, Disability Adjusted Life Years (DALY), Gefahrstoffverordnung, Lungenkrebs, Mesotheliom, Technische Regeln für Gefahrstoffe

1 Asbestos Regulations for the Protection of Workers in the Federal Republic of Germany

1.1 Introduction

Asbestos, the “magic mineral”, is a natural substance that has been used for more than 100 years in industrial and consumer fields. More than 3,500 products were produced from asbestos. About 4.4 Million (M.) tonnes were used in (West) Germany between 1950 and 1985. Today, asbestos is still mined in the Russian Federation, the People’s Republic of China, Kazakhstan, Brazil, Zimbabwe, which cover approximately 96% of the production worldwide, and others. At least until the early 1990s, asbestos products were ubiquitous in Germany in applications, where high temperatures can occur (high-temperature insulation and gaskets, fire protection, brake pads, clutch linings, protective clothing and gloves). Furthermore, approximately 900 M. m^2 of asbestos-cement products, with a service life of 40–50 years, were used in West Germany; in the former German Democratic Republic, commonly referred to as “East Germany”, approximately 10 M tons of asbestos products were used.
The health risks of asbestos, to which primarily workers are exposed, were recognised as early as the turn of the 20^{th} century. Lung cancer in connection with asbestosis has been officially recognised as an occupational disease in Germany since 1942. The cause of the carcinogenic effect, however, remained unclear for many years. In 1972, Pott and Stanton published the hypothesis that sufficiently long and thin bio-stable fibres will exhibit a carcinogenic effect. The fibre hypothesis is now supported by a large body of evidence from animal studies and hence is internationally accepted. Other bio-persistent fibres can also cause cancers.
In Germany some first measures against asbestos exposure were already implemented in 1940. The Reichsarbeitsministerium and the Reichsversicherungsamt implemented a directive aimed to protect workers in companies using asbestos against asbestos dust exposure. In addition, as early as the 1950s the statutory accident insurance institutions conducted work place measurements, risk assessments and developed and implemented based on the measurement results preventive measures against asbestos exposure. The first safeguards were only introduced in 1972, addressing the dangers posed by asbestos in the workplace far too late. In the subsequent years, these led to considerable reductions in asbestos exposure in workplaces. However, these precautions were not sufficient to protect the safety of the workers, as later scientific evidence revealed that they were still associated with a health risk of 1% for an exposure period of 35 years. In 1993, it was recognised that it is not possible to guarantee “controlled handling” of asbestos products over their entire lifetime. This knowledge led to the establishment of a complete ban on manufacturing, sale and use of asbestos products in West Germany (Annex II No. 1 (Asbestos), Hazardous Substances Ordinance; § 1 Abschnitt 1, Spalte 2 des Anhangs, der Verordnung über Verbote und Beschränkungen des Inverkehrbringens gefährlicher Stoffe, Zubereitungen und Erzeugnisse nach dem Chemikaliengesetz (Chemikalien-Verbotsverordnung – ChemVerbotsV). The European Union subsequently decided in 2005 to completely discontinue the use of asbestos (Regulation (EC) No. 1907/2006 of the European Parliament and of the Council (REACH), Article 67 in connection with Annex XVII, No. 6 (Asbestos fibres)).
The latency period between asbestos exposure and the development of cancer is, on average, more than 30 years. The full consequences of insufficient occupational

safety have therefore only now become clear, as asbestos usage continued to increase in Germany until the mid-1970s. About 3,500 asbestos-related occupational disease cases are currently diagnosed each year. Nearly every second one incidence of occupational disease with a fatal outcome is caused due to asbestos exposure. Conservative estimates by the European Commission showed that there are approximately 8,000 premature deaths due to asbestos exposure in the EU per annum; the International Labour Organisation (ILO) in Geneva estimated that annually 100,000 people die worldwide due to asbestos exposure.
As early as 1982, the predecessor institution of the German Federal Institute for Occupational Safety and Health (BAuA) published a catalogue of substitute materials for asbestos. In addition, the predecessor institution of the German social accident insurance institution (HVBG) documented the substitute materials for asbestos in a comprehensive catalogue (Asbestersatzstoff-Katalog – Erhebung über im Handel verfügbare Substitute für Asbest und asbesthaltige Produkte, HVBG, 1985, www.dguv.de/ifa/Fachinfos/Asbest-an-Arbeitspl%C3%A4tzen/Anwendung-und-Substitution/index.jsp).
This initiated innovative efforts of the industry to find non-hazardous substitutes. Although the industry still held a highly critical view of the possibilities for completely replacing asbestos in the late 1980's – and only envisaged a time frame stretching beyond the year 2000 – the withdrawal introduced in 1990 was finalised with an outright ban in 1995. The economic consequences initially feared, for example for the cement industry, did not materialise. On the contrary, Germany's pioneering role with respect to producers of asbestos substitute products resulted in a competitive advantage on the international market. One significant step in recent years is the targeted development of bio-soluble fibres by the German mineral-wool industry; these fibres tackle the root of the problem of the cause of fibre-related cancers.

1.2 Classification

Asbestos is classified on the European level, in Annex IV of the CLP Regulation (EC) No. 1272/2008, as **a carcinogenic substance of category 1** (Directive 67/548/EEC) or **1A** (CLP) (Carc. Cat. 1; R 45, T; R 48/23 or Carc. 1A; H350, STOT RE 1; H372[1]).

[1] Route of exposure cannot be excluded. For certain hazard classes, e.g. STOT, the route of exposure should be indicated in the hazard statement only if it is conclusively proven that no other route of exposure can cause the hazard in accordance to the criteria in Annex I. Under Directive 67/548/EEC the route of exposure is indicated for classifications with R48 when there was data justifying the classification for this route of exposure. The classification under 67/548/EEC indicating the route of exposure has been translated into the corresponding class and category according to this Regulation, but with a general hazard statement not specifying the route of exposure as the necessary information is not available.

1.3 Ban on the Manufacture and Use of Hazardous Substances Containing Asbestos

The manufacture and use of asbestos fibres, and of products and mixtures to which these fibres are intentionally added, is banned.

(Article 67 in conjunction with Annex XVII (6) (Asbestos fibres) of Regulation (EC) No. 1907/2006; see also Article 16 and/or Annex II (1) of the German Hazardous Substances Ordinance – GefStoffV)

1. The following fibrous silicates are considered to be asbestos in accordance with Annex XVII (6) of the Regulation (EC) No. 1907/2006 and No. 2 and Annex II (1) of the German Hazardous Substances Ordinance:
2. Actinolite, CAS number 77536-66-4;
3. Amosite, CAS number 12172-73-5;
4. Anthophyllite CAS number 77536-67-5;
5. Chrysotile, CAS number 12001-29-5 and CAS number 132207-32-0;
6. Crocidolite, CAS number 12001-28-4

German Hazardous Substances Ordinance
Section 5
Prohibitions and Restrictions
Article 16
Restrictions on Manufacture and Use

(1) Restrictions on manufacture and use of certain substances, preparations and articles arise from Article 67 in combination with Annex XVII of Regulation (EC) No. 1907/2006.
(2) In accordance with Annex II, there are further restrictions on the manufacture and use for substances, preparations and articles mentioned therein.

Annex II
(to Article 16 paragraph 2)
Special Restrictions Pertaining to the Manufacture and Use of Certain Substances, Preparations and Articles
Number 1
Asbestos

(1) Work shall be prohibited on parts containing asbestos in buildings, equipment, machines, installations, vehicles and other articles. Sentence 1 shall not apply with respect to

1. demolition work,
2. reconstruction and maintenance work with the exception of work leading to removal of the surface of asbestos products unless low-emission processes

are involved which are recognised by the authorities or by the statutory accident insurance institutions.
The processes which entail prohibition of the removal of surfaces containing asbestos shall include in particular abrasion, pressure cleaning, brushing and drilling.

3. Activities with measurement technology support which lead to the removal of the surface of asbestos products and which must be carried out in order to obtain recognition as a low-emission procedure.

The prohibited work according to sentence 1 shall also include covering, superstructure and erection work on asbestos cement roofs and wall claddings, and cleaning and coating work on uncoated asbestos cement roofs and wall claddings. The further use of objects and materials containing asbestos which arise during work for other purposes than waste disposal or waste recycling shall be prohibited.
(2) The extraction, preparation, further processing and reuse of mineral raw materials which occur naturally and preparations and articles manufactured therefrom which contain asbestos with a mass content of more than 0.1 per cent shall be prohibited.
(3) Waste products containing asbestos shall be provided with the labelling mentioned in Article 67 in combination with Annex XVII number 6 column 2 (3) and Appendix 7 of this Annex of Regulation (EC) No. 1907/2006.
(4) Paragraphs 1 and 3 shall also apply to private households.

Article 17
National Exemptions from Restriction Regulations according to Regulation (EC) No. 1907/2006

(1) The restrictions according to Article 67 in combination with Annex XVII Number 6 (asbestos fibres) of Regulation (EC) No. 1907/2006 shall not apply to the manufacture and use of diaphragms containing chrysotile for chlorine alkali electrolysis, including the asbestos-bearing raw materials needed for their manufacture, in systems existing on 01.12.2010 until the end of their use if

1. no asbestos-free substitute substances, preparations or articles are available on the market or
2. use of the asbestos-free substitute substances, preparations or articles would result in unacceptable hardship

and the concentration of asbestos fibres in the air at the workplace is below 1 000 fibres per cubic metre.

1.4 Safeguards for Handling Asbestos in the Workplace

1.4.1 Legal requirements of German Hazardous Substances Ordinance (GefStoffV)

This is governed by the following:

- the provisions of Section 4 of GefStoffV - Protective Measures
- the special provisions for particulate hazardous substances as set out in Annex I (2) of GefStoffV,

- in particular the **supplementary provisions concerning the protection against risks from asbestos as set out in Annex I (2.4) of GefStoffV:**

Annex II
Special Provisions for Certain Hazardous Substances and Activities
Number 2
Particulate Hazardous Substances

2.4 Supplementary Provisions concerning the Protection against Risks from Asbestos

2.4.1 Identification and Assessment of the Risk from Asbestos

The employer shall ascertain in the risk assessment under Article 6 whether workers are or can be exposed to asbestos dust or dust from materials containing asbestos during activities. This applies in particular with respect to demolition, reconstruction and maintenance work involving articles or materials containing asbestos. In particular the employer shall identify whether asbestos is presented in weakly bonded form.

2.4.2 Notification to the Authority

(1) Activities according to number 2.1 sentence shall be notified to the competent authority. The employer shall grant the workers and their representative body access to the notification.

(2) The notification shall be made at the latest seven days prior to commencement of the activities by the employer and shall contain at least the following details:

1. location of the work site,
2. types and quantities of asbestos used or handled,
3. activities performed and processes applied,
4. number of workers involved,
5. starting date and duration of the work,
6. measures taken to limit the release of asbestos and to limit the workers' exposure to asbestos.

(3) Demolition, reconstruction and maintenance work involving asbestos shall only be performed by specialist companies whose personnel and safety facilities are suitable for such activities. During work it shall be ensured that at least one person with expert knowledge with power to issue directions is working on site. The expertise shall be demonstrated by the successful participation in a course for the acquisition of expert knowledge recognised by the competent authority. Proofs of expertise shall be valid for a period of six years. In derogation from sentence 4 proofs of expertise that have been acquired before 1 July 2010 shall remain valid until 30 June 2016. If a state approved further training course is being attended during the period of validity of the proof of expertise, the period of validity shall be extended by six years, from the date of the certificate proving the completion of the further training course.

(4) Demolition and reconstruction work where asbestos is present in weakly bonded form shall only be performed by specialist companies which have been authorised to perform such activities by the competent authority. The authorisa-

tion shall be issued on written or electronic application from the employer if the latter has demonstrated that the personnel and safety facilities needed for such activities are available to the extent necessary.

2.4.3 Supplementary Protective Measures concerning Activities involving Exposure to Asbestos

(1) The spread of asbestos dust shall be prevented by the dust-tight separation of the working area or by means of suitable protective measures which ensure an equivalent safety standard.
(2) It shall be ensured by an adequately dimensioned room ventilation system that the working area is thoroughly aired and a sufficient negative pressure is maintained.
(3) The working area shall be equipped with a personnel airlock with shower and a materials airlock.
(4) The workers shall be provided with suitable respiratory protective equipment, protective suits and, where necessary, other personal protective equipment. The employer shall ensure that the workers use the personal protective equipment.
(5) Contaminated personal protective equipment and the work clothing shall either be cleaned or disposed of. It may also be cleaned in suitable facilities outside the company. The cleaning shall be performed in such a way that workers are not exposed to asbestos dust. The materials to be cleaned shall be kept and transported in enclosed, labelled containers.
(6) The workers shall be provided with suitable washrooms with showers.
(7) Prior to application of demolition techniques materials containing asbestos shall be removed where possible.

2.4.4 Work Schedule

Prior to the commencement of activities involving asbestos, and in particular demolition, reconstruction and maintenance work, the employer shall draw up a work schedule.
The work schedule shall provide for the following:

1. a description of the working procedure and the work equipment used to remove and dispose of asbestos and materials containing asbestos,
2. details of the personal protective equipment,
3. a description of how a check is made that there is no longer a risk from asbestos in the working area after the completion of the demolition and reconstruction work.

2.4.5 Supplementary Provisions concerning the Instruction of Workers

(1) The workers shall be given regular instruction on the specific activity. The work schedule according to number 2.4.4 shall be taken into account here.
(2) The subject of the instructions shall encompass in particular the following items:

1. the properties of asbestos and its effects on health, including the synergistic effects of smoking,
2. the types of products and materials likely to contain asbestos,

3. activities during which asbestos exposure may arise and the significance of measures taken to minimise exposure,
4. the proper application of safe processes and personal protective equipment,
5. measures taken in the case of operational disturbances,
6. proper waste disposal,
7. medical examinations according to the Ordinance on Occupational Health Care.

1.4.2 Technical Rules for Hazardous Substances (TRGS)

TRGS 519 "Asbestos – Demolition, reconstruction or maintenance work"
(Version: January 2007, amended January 2014 www.baua.de/de/Themen-von-A-Z/Gefahrstoffe/TRGS/TRGS-519.html)

The TRGS 519 applies to the protection of workers and other people, who work with asbestos and asbestos-containing hazardous substances during demolition, reconstruction or maintenance work and waste disposal. TRGS 517 applies to activities involving asbestos-containing mineral raw materials, and preparations and articles manufactured from them.
This TRGS does not apply to activities involving other fibrous dusts. TRGS 521 applies to demolition, reconstruction and maintenance work with using carcinogenic biopersistent mineral wools.
TRGS 519 specifies general requirements for the protection of workers and other (exposed) people according to the Hazardous Substances Ordinance and in particular in its annex III No. 2.4 "Supplementary asbestos safety measures". If the regulations cannot be met, at least equivalent protective measures must be taken. The reasons for the deviation from the regulation must be justified in the risk assessment document.
Even if the asbestos fibre concentration at the workplace does not exceed the threshold value of 10,000 fibres/m^3, as given in Number 2.8 TRGS 519, there is still a cancer risk. Further measures to reduce the asbestos fibre concentration are therefore to be aimed at.

TRGS 517 "Activities with potentially asbestos-containing mineral raw materials and preparations and articles manufactured from them"
(Version: January 2007; with changes and additions: July 2013,
www.baua.de/de/Themen-von-A-Z/Gefahrstoffe/TRGS/TRGS-517.html)

This TRGS contains safeguards whose application is a prerequisite for activities with natural asbestos-containing mineral raw materials and preparations and articles manufactured from them within the scope of this TRGS.

This TRGS applies to the following:
- the extraction and preparation of naturally occurring asbestos-containing mineral raw materials in quarries (e.g. gravel, stone chippings, crushed sand, fines);

- further processing of asbestos-containing mineral raw materials and preparations and articles made from them in the field of structural and civil engineering (e.g. road construction and track laying, concrete, asphalt);
- the recycling and reuse in road construction (e.g. treatment and reinstallation of recycled materials, asphalt production);
- the processing of ashlar (e.g. soapstone in furnace construction);
- cold planing of road surfaces.

Furthermore, this TRGS applies to activities:

- when entering and securing underground caves in asbestos-containing rock;
- involving the use of asbestos-containing talc as a filler, release agent or lubricant (e.g. in the production of cables, tyres or rubber products);
- involving the use of asbestos-containing fillers and aggregates for other purposes (e.g. for the production of asphalt and concrete).

For activities with potentially asbestos containing materials according to this TRGS which are not specified in Paragraph 2 and 3, Number 3.1 Paragraph. 3 shall be applied accordingly (own translation).
The employer can assume that the mass content of asbestos in mineral raw materials such as those found in quarries for example in the Federal Republic of Germany, is less than 0.1%, in which case the prohibition on manufacture and use set out in Article 16 Para. 2 in conjunction with Annex II No. 1 Para. 2 GefStoffV does not apply. Even if the asbestos mass content falls below of 0.1%, an asbestos exposure level may be reached that requires the use of certain protective measures (as described in TRGS 517) (own translation).

1.5 Use of Diaphragms for Chlorine-Alkali Electrolysis

According to Article 67 in combination with Appendix XVII, Chpt. 6, of Regulation (EC) No. 1907/2006 manufacture, placing on the market and use of asbestos fibres are prohibited (Article 17 Hazardous Substance Ordinance). The Member States may exempt chrysotile from the ban to be used in **diaphragms for existing electrolysis** installations, but only until they reach the end of their service life, or until suitable asbestos-free substitutes become available. Since 2011 the Member States that make use of this exemption shall provide a report to the European Commission, e.g. on the availability of asbestos-free substitutes for electrolysis installations, the efforts undertaken to develop such alternatives, the envisaged date of the end of the exemption, and the protection of the health of workers in the installations. In the manufacture and use of diaphragms containing chrysotile for chlorine-alkali electrolysis, it must be ensured that fibre concentration in the air at the air pollution in the workplace is less than 1,000 fibres/m^3 (Art. 17 (1) GefStoffV).

2 Import and consumption of asbestos per year (total and per major uses and forms)

2.1 Past import and consumption

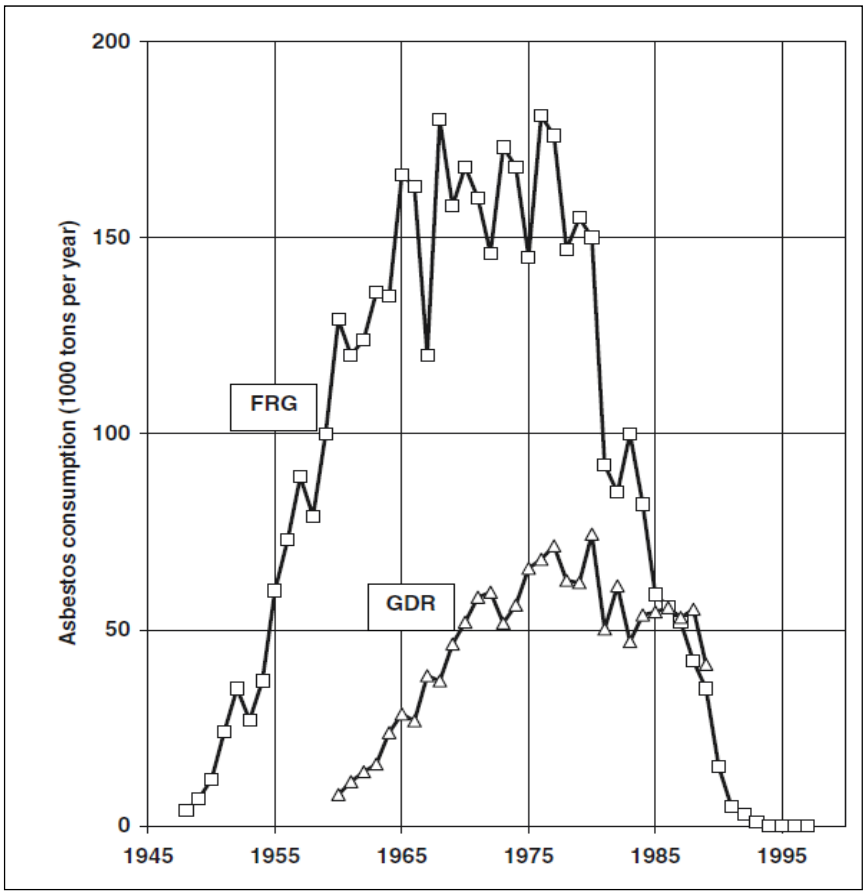

Fig. 2.1 Asbestos consumption from 1948 to 1999 in West and East Germany (Source: German Statutory Accident Insurance)
FRG: Federal Republic Germany, GDR: German Democratic Republic

In Germany there are no known asbestos mines. Thus, with the exception of minerals containing small quantities/proportions of asbestos fibres, the whole issue of asbestos exposure in Germany relates to asbestos imports and its use in production and in asbestos-containing materials. Between 1950 to 1990 about 4.35 M. tons were imported into Germany (FRG and GDR). These imports mainly comprised crysotile asbestos minerals (ca. 96%) and only small amounts of crocidolite (3%) and amosite (1%) asbestos minerals.

Fig. 2.1 shows a strong increase of asbestos consumption in the **FRG** since 1948 up to 170,000 tons in 1965. After 1965 asbestos consumption remained quite stable on a high level of approximately 160,000 tons/year, whereby since 1980 a sharp decrease in consumption caused by substitution prevailed, e.g.in the year of the German unification 1989 an asbestos consumption of about 50,000 tons was reached (HVBG, 2003; DGUV, 2013). Since asbestos spraying was prohibited in 1979, a wide

range of asbestos regulations were implemented resulting in the complete ban of asbestos production, usage and placement on the market in 1993, so that asbestos consumption nearly disappeared in Germany according to the Hazardous Substances Ordinance (HAGEMEYER et al., 2006). Fig. 2.2 shows products and product groups/categories that were manufactured for which the imported asbestos was used during the manufacturing process in the **FRG** in 1970's.

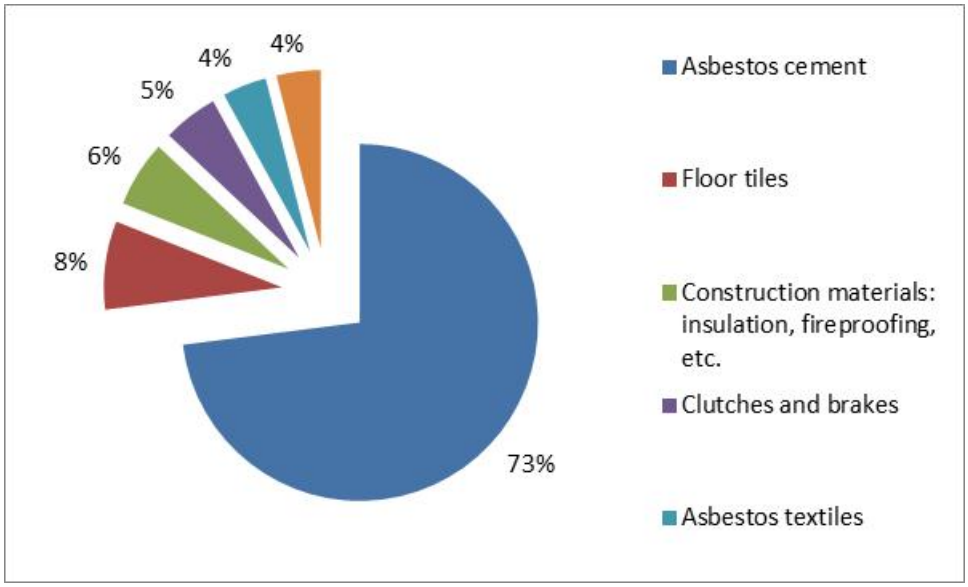

Fig. 2.2 Distribution of asbestos uses on product groups/categories (Source: BBSR, 2011; BG Bau, 2008)

Fig. 2.3 shows the asbestos import of the former GDR since 1960:

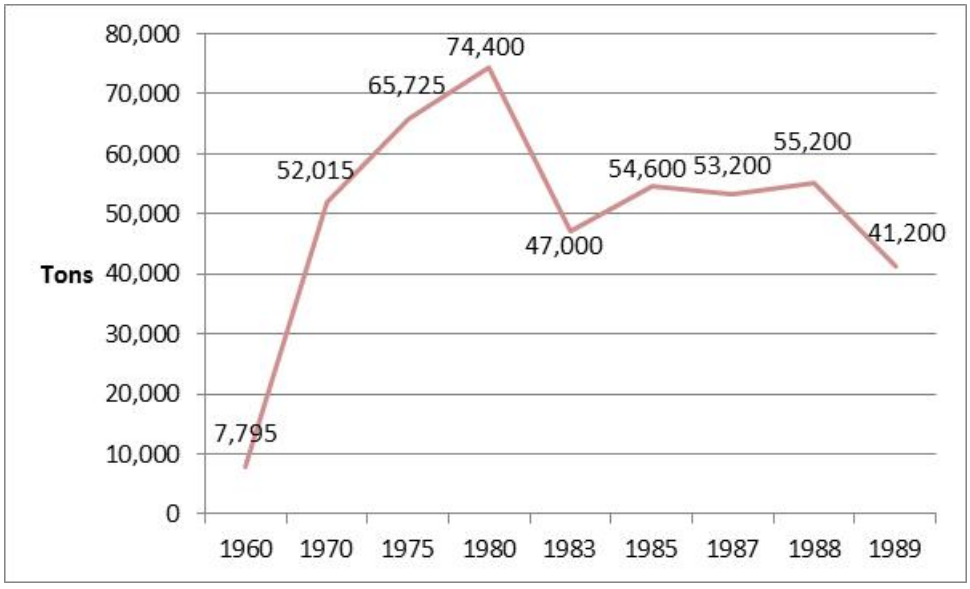

Fig. 2.3 Asbestos import in the GDR from 1960 to 1989 (Source: DGUV, 1995; UBA 1991)

In the former **GDR** (German Democratic Republic) asbestos imports started in about 1960 (7,800 tons). Since then asbestos import increased up to a level of about

74,000 tons in 1980, and decreased slightly afterwards to a level of about 55,000 tons in 1988 (HVBG, 1995). Overall about 1.4 M. tons (1,393,900 tons) asbestos minerals were imported mainly from Russia. Given the average number of inhabitants of the former GDR of 17 M., about 2.8 kg per year per capita were consumed.[2] For the FRG a per capita consumption of less than 1 kg per year has been estimated assuming an average number of inhabitants of the former FRG of about 60 M.
The asbestos imports of the GDR mainly consist of chrysotile asbestos and consist only of small amounts of amosite, anthophyllit and crocydolith asbestos (used especially for acid protection). Actinolite and tremolite asbestos was not used (AS aktuell, 1991). Since 1985 the import of crocydolith asbestos was prohibited. However, some small amounts of crocydolith asbestos were imported from the Netherlands (AS aktuell, 1991). In addition, it cannot be completely ruled out that some crocydolith exposure, and by import of talcum some exposure of actinolite and tremolite as impurities may have arisen by imports e.g. of asbestos paper and sealing compounds (AS aktuell, 1991).
The GDR production of asbestos containing materials covered the broad range of well-known asbestos products (see Fig. 2.4). However, in the GDR compared to the FRG no asbestos containing floor covering were used for construction. In addition, the use of shotcrete asbestos was already forbidden in 1969, and asbestos shotcrete insulations were carried out only with two exceptions in cases of fire protection (AS aktuell, 1991; DGUV, 2013).

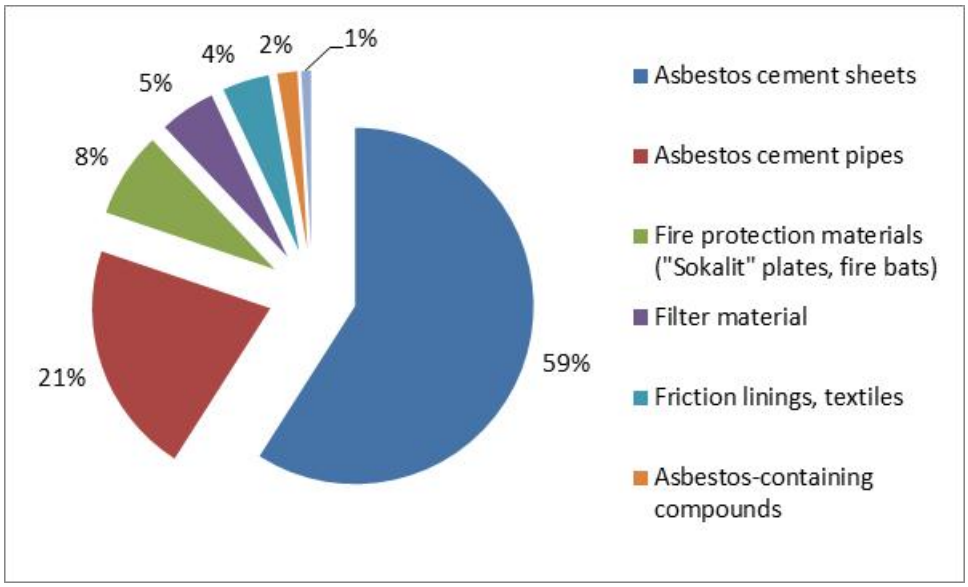

Fig. 2.4 Distribution of asbestos uses on product groups in the GDR in 1979 (Source: UBA, 1990; Arbeitshygieneinspektion Schwerin, 1981)

The main area of application of asbestos was asbestos cement (a share of 75% was estimated for both together, the FRG and the DGR (BBSR, 2010)). Thus about 4.3 Mio. (M.) tons of asbestos were used for asbestos cement products (strongly bound). If one assumes that these products contain 10% of crude asbestos, this would add up to a production of about **43 M. tons of asbestos cement**. The remaining part of

[2] In a report of the occupational hygiene of the municipality of Schwerin from 1981 an annual yearly asbestos consumption of 56,000 tons was estimated for the GDR (Arbeitshygieneinspektion Schwerin, 1981). Using this figure the asbestos consumption per capita amounts to 3.3 kg per capita.

crude asbestos (about 1.4 M. tons) was used for products of weakly bound asbestos. Assuming an asbestos content of 50% of product mass about **2.8 M. tons of products of weakly bound asbestos** were produced (BBSR, 2010).
Due to the asbestos ban in 1993, with the exemption of the chlorine-electrolysis processes, contact to asbestos-containing materials at the workplace may occur today only during demolition, reconstruction or maintenance works and when using asbestos containing mineral raw materials.

2.2 Current import and consumption

Tab. 2.1 Import for chlorine-electrolysis
(Source: Federal Statistical Office)

Import (SITC[3]-Subgroup 278.4/ Asbestos)	
2010	72.5 tons
2009	38.1 tons
2008	54.1 tons
2007	54.0 tons

According to Article 67 in combination with Appendix XVII, Chpt. 6, of Regulation (EC) No. 1907/2006 manufacture, placing on the market and use of asbestos fibres is prohibited (see also Article 17 Hazardous Substance Ordinance). The Member States may exempt chrysotile to be used in **diaphragms for existing electrolysis** installations from the ban, but only until they reach the end of their service life, or until suitable asbestos-free substitutes become available. Since 2011 the Member States that make use of this exemption shall provide a report to the European Commission, e.g. on the availability of asbestos-free substitutes for electrolysis installations, the efforts undertaken to develop such alternatives, the envisaged date of the end of the exemption, and the protection of the health of workers in the installations.
Based on this exemption Solway (Rheinberg) and Dow Chemicals (Stade) imported chrysotile asbestos. After a testing period from 2005 to 2011, Solway substituted chrysotile asbestos with Polyamide fibres. At Dow Chemicals (Stade) substitution proved to be more difficult. The procedure used allows an energy efficient, further processing of the produced substance (10%-sodium hydroxide) which is not possible when using alternative procedures. Since 2010 Dow is running laboratory tests on asbestos-free membranes, and since 2012 long-term studies testing these alternatives during production have been initiated. Given a positive outcome of the long-term tests, a stepwise substitution to asbestos-free diaphragms is envisaged in 2015 and 2025. Due to production risks of the use of the alternatives and a high degree of capacity utilisation substitution shall follow the regular exchange cycle of the diaphragms. The asbestos-free alternatives, which are based on a Teflon-coated technology, have higher material costs compared to asbestos diaphragms and as well slightly higher energy consumption during production is expected.

[3] Standard International Trade Classification, Revision 4.

For the diaphragms Dow uses on average 30 to 50 tons asbestos per year which are imported from Union Carbide-Mines in Canada. The chrysotile fibres are packed in twice sacks in Germany. The containers are placed in the Stade plant in a lock, they are opened automatically and discharged. In order to open the bags they are transferred automatically via a sluice into a separate chamber, where they are cut open by a machine. From there, the chrysotile asbestos fibres are directly transferred into an aqueous solution, which is subsequently applied to the diaphragms. The packaging material is shredded and filled into containers which are then burned in a combustion chamber destroying the fibrous structure of chrysotile asbestos. In the diaphragm chrysotile asbestos is part of a PTFE matrix and enclosed by the cell wall. The removal of chrysotile asbestos takes place under water, which is then (concentrated) transferred into a closed system and pelletized with aggregates and immediately burned to avoid the release of any asbestos. The ECHA and the labour inspectorate consider the use of asbestos diaphragms at DOW as safe for the employees.
The work place concentrations at DOW are regularly checked via measurements at six locations in agreement with the recommendations of the statutory accident insurance association. The measurements according to VDI 3492 demonstrates compliance with the threshold value of 1,000 fibres/m^3 according to § 17 Chpt. 1 Hazardous Substance Ordinance. The measured fiber concentration fulfills the exposure-risk relationship for asbestos of the Committee on Hazardous Substances (AGS) – also taking into account from 2018 on, the lowered acceptance threshold (Announcement on Hazardous Substance 910, 2008).[4] The measurement protocol provided by the end of 2010 measured exposure concentrations of less than 100 fibres/m³ (in one case less than 300 fibres/m³). Protective clothing and a lock system are provided for extremely rare visits to the closed chambers. Twelve workers are employed in the affected area, who are medically supervised.

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[4] Given an exposure time of 40 years, 240 working days per year and exposure duration of 8 hours per working day.

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3 Import of asbestos-containing materials

In Germany a restriction on manufacture, placing on the market and use of asbestos fibres is in place since 1993. In addition, the REACH-regulation implements a ban on Asbestos. However, illegal import of asbestos-containing materials and products from Non-EU countries violating the mass-volume threshold of 0.1% may happen.
To protect health at work, at home and in leisure areas various general and special European directives for technical products in the **Product Safety Act** (ProdSG) and its subordinate special regulations (e.g. regarding machines, electrical devices, toys, etc.) are implemented in Germany. The Equipment and Product Safety Act (GPSG) sets rules for the purchase of technical work equipment specifying requirements to ensure occupational safety and health protection. The way in which these basis requirements are met is the responsibility of the producer. The Product Safety Act (ProdSG) applies to all products intended for private use by consumers and which are brought into circulation commercially. The corresponding European Product Safety Directive (ProdSRI, 2001/95/EG) only applies, if there are no specific provisions under other statutory regulations.
In order to enforce the rules on Product safety **market surveillance** plays a crucial role with respect to consumer product safety and occupational safety. In the European Union, market surveillance for non-food consumer products is the responsibility of the Member States. Under the General Product Safety Directive (GPSD), the Member States nominates or establishes authorities that have responsibility for market surveillance.[5]
The **Federal Institute for Occupational Safety and Health** (BAuA), as a so-called "designated national authority" (DNA), supports the authorities of the federal states of Germany responsible for market surveillance in the performance of this activity.
Supported by the GPSG and the related ordinances, the BAuA carries out the major, central notification procedures in the field of all technical products governed by the GPSG. The most important task of the BAuA is the operation of the National Contact Point for dangerous technical products. This involves collecting of notifications concerning dangerous products in the Internet-supported information and communication system for the pan-European market surveillance[6] (ICSMS) and the prompt official communication of notifications of the competent German authorities to the Member States (RAPEX). The "designated national authority" is also responsible for the official publications of all German prohibition orders and the provision of information to the general public with respect to other product deficiencies.
RAPEX is the EU rapid alert system that facilitates the rapid exchange of information between Member States and the Commission on measures taken to prevent or restrict the marketing or use of products posing a serious risk to the health and safety of consumers –with the exception of food, pharmaceutical and medical devices, which are covered by other mechanisms. From 1st January 2010 onwards, with regards to goods subject to the EU harmonisation regulation, the system also facilitates the rapid exchange of information on products posing a serious risk to the health and safety of professional users and on those posing a serious risk to other public interests protected via the relevant EU legislation (e.g. environment and security). Both measures ordered by national authorities and measures taken voluntarily by producers and distributors are reported by RAPEX. On every Friday the European Commis-

[5] http://ec.europa.eu/consumers/safety/projects/market_surveillance_enforcement_en.htm
[6] www.icsms.org/icsms/App/index.jsp

sion publishes an inventory on dangerous products noticed by the competent authorities.
For getting an impression on the number of asbestos-containing products imported illegally to Germany the RAPEX search engine can be used.[7] Entering the term “asbestos” in the search mask produces 7 entries for the time period from 2006 to 2010 (14 August 2013, 5 p.m): 1 electrical appliance, 2 garden torches, 1 garden lamp, 3 thermo flags. For these cases a sales ban was issued or a withdrawal from the market was ordered by the authorities, because of the serious health risk the product can pose to consumers. Of course, not all illegally imported asbestos-containing products will be detected by the authorities. But given the system of market surveillance implemented in the EU it seems plausible to assume that illegal product imports at least on a large scale will be detected by market surveillance such that compulsory or voluntary measures can implemented to protect the consumers.

[7] http://ec.europa.eu/consumers/safety/rapex/alerts/main/index.cfm?event=main.search

4 Domestic production of asbestos (if applicable)

Not relevant

5 Domestic production of asbestos-containing materials

Due to the production ban of asbestos-containing materials in Germany since 1993 legal production of asbestos-containing materials is prohibited. However, production of asbestos containing materials can arise in products as impurity. An important example is the mining of mineral and stone raw materials. Crushed-Rock and Split stemming from stones like Gabbro, Dorit, Greenstone, Amphibolite, or Basalt which are used in road making, truck construction, and civil-engineering (KOLMSEE et al., 2010). Minerals like Soapstone and Talc powder also may contain asbestos. Because of its low hardness Soapstone is used in art classes and handicraft lessons, and also for Soapstone stoves because of its high resistance to temperature.

5.1 Asbestos in Soap stones and Talc powders (KOLMSEE et al., 2010)

Raw materials like Crushed-Rock, Talc powder and Soapstones may contain asbestos. In general, manufacture and use of minerals exceeding 0.1 weight % is not permitted. This weight-% limit applies to asbestos fibres with length > 5 µm and width < 3 µm and an aspect ratio 3:1 (WHO-definition). The asbestos which is contained in raw materials (Crushed-Rock, Soapstones and Talc powders) mainly appears as splinter or needle of asbestos crystals, and, hence is thicker and shorter than asbestos fibres according to the WHO-definition. Asbestos fibres typically arise in the course of production processes on these raw materials like braking. Therefore, there was a need to extend the definition of the asbestos weight-% in accordance with the aims stated in the Hazardous Substances Ordinance (see Para. 2 Definitions TRGS 517). Procedures for the assessment of the asbestos content in raw materials are provided with the German Technical Rule for hazardous substances TRGS 517 (Annex 2, No. 1 – 4). The TRGS 517 applies to activities involving asbestos-containing mineral raw materials, and preparations and articles manufactured from them.

Soapstones may contain chrysotile or amphibole particles like tremolite, actinolite and anthophyllite. Chrysotile appears in a fibrous form, whereas amphibole particles are splinter-shaped. With respect to processes like drilling, sanding and sawing, dust evaporates may contain asbestos fibres. Burnt Soapstone (1,300°C – 1,400°C) does not contain asbestos. Between 2000 and 2001 the IFA (Institut für Arbeitsschutz – Institute for occupational safety of the German Statutory Accident Insurance) conducted an analysis of 35 samples of Soapstones. However, the samples comprised Soapstones from Germany, but as well from Brazil, China, Finland, India, and Norway. In 9 out of the 35 material samples varying concentrations of asbestos was found in the samples (26%) with 2 of the samples showing a mass weight exceeding the threshold level of 1% (6%). Due to this the use of Soapstones in educational institutions of most of the Federal States of Germany was prohibited.

Talc powder may contain amphibole particles, mainly tremolite, actinolite and seldom anthophyllite. Scanning electron microscopy (SEM) analysis show that mainly the amphibole particles are not fibrous, but splitter-shaped. Thus similar to the Soapstones the weight percentage of the amphibole particles does not show the weight percentage of asbestos in Talc powder. Between 1996 and 2005 the IFA conducted

an analysis of 55 samples of Talc powder using SEM and applying the rules of TRGS 517 for the assessment of the asbestos content which gives an indication of the asbestos content of Talc powder on the German Talc powder market. In 13 out of 57 samples asbestos was found (23%) with 2 of the samples containing a mass weight exceeding the threshold level of 1% (4%).

In the case that minerals contain asbestos minerals as impurities below a threshold level of 0.1 mass-percentage the extraction of these minerals and placing them on the market is allowed (No. 1, Para. 5 TRGS 517 in connection with Hazardous Substance Ordinance). However, this still applies to cases where the mineral contains less than 0.1 mass-percentage of asbestos even if the asbestos concentration during extraction, treatment, and recycling can be above the acceptance level of 10,000 fibres/m^3 (No. 1, Para. 5 TRGS 517). The BG for the raw materials and chemical industry estimated that the acceptance level during mining and treatment is violated in ten out of 2,000 active quarries in Germany (Personal communication, BG RCI). In these cases additional safety measures according to TRGS 517, No. 4, and ideally also according to No. 5 have to be applied in connection with No. 1, Para. 5 TRGS 517.

5.2 Asbestos waste disposal

The Closed Substance Cycle and Waste Management Act (Kreislaufwirtschaftsgesetz (KrWG)) defines waste as a product. Thus disposal of waste containing asbestos (i) as outcome of demolition work in asbestos polluted buildings or (ii) waste of technical equipment containing asbestos can be considered as the production of asbestos-containing materials.
According to the German Confirmation Act (Nachweisverordnung – NachwV, implemented in 1995) asbestos waste disposal has to be documented (accompanying document procedure – Begleitscheinverfahren). In addition, since 1st January 2002 the European Waste Catalogue (EWC) (implemented in national law by the Directive on the List of Waste Materials (Abfallverzeichnis-Verordnung – AAV) is in place providing information on statistics on asbestos containing waste disposal. The EU-wide provision governs the classification of hazardous waste. According to this provision asbestos waste disposal is classified as hazardous, if the mass-percentage of asbestos in the waste exceeds 0.1%. In this case the classification number is marked by an asterisk (*). The following classification for asbestos containing waste is provided according to AAV:
06 07 01* Asbestos waste from chlorine-alkali electrolysis[8]
06 13 04* Waste from asbestos containing material
10 13 09* Asbestos containing waste from asbestos-cement production
16 01 11* Asbestos-containing brake pads
16 02 12* Used Technical equipment and devices containing asbestos
17 06 01* Insulating material containing asbestos (unbounded)
17 06 05* Asbestos containing building materials (bounded)

[8] These numbers are not shown in the statistics if the number of user is smaller then 3. In the case of chlorine-alkali electrolysis there are only two users.

Tab. 5.1 gives an overview on quantities of different types of asbestos containing disposal:

Tab. 5.1 Asbestos waste disposal (in 1,000 tons)
(Source: Federal Statistical Office)

	(06 13 04*) Waste from asbestos containing materials	**(10 13 09*) Asbestos containing waste from asbestos-cement production**	**(16 01 11*) Asbestos-containing brake pads**	**(16 02 12*) Used Technical equipment and devices containing asbestos**	**(17 06 01*) Insulating material containing asbestos**	**(17 06 05*) Asbestos containing building materials**	**Sum**
2011 (pre-limi-nary)	0.7	-	0.0	0.5	23.3	855.4	879.9
2010	0.5	-	0.0	9.4	4.3	413.6	427.8
2009	0.7	-	0.0	8.7	4.2	458.1	471.7
2008	0.6	-	0.0	6.6	5.7	363.9	376,8
2007	0.6	0.1	0.1	6.2	4.7	352.9	364.6
2006	0.7	-	0.1	8.0	5.0	307.4	321.4
2005	3.8	-	0.1	0.9	4.6	323.6	333.0
2004						268.3	268.3
2003	-	-	-	-	-	270.6	270.60
2002	-	-	-	-	-	265.0	265.0
2001	-	-	-	-	-	303.0	303.0
Sum						4,181.8	**4,282.1**

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6 Estimated total number of workers exposed to asbestos in the country

An actual number of workers exposed is not directly available. However, based on statistics of the institutions for statutory accident insurance the number can be estimated.

6.1 Announcement for medical examinations (GVS)

A special and central registration and medical care agency (GVS – Gesundheitsvorsorge) located in Augsburg was founded by the institutions for statutory accident insurance and prevention. The institution started its work in 1972 under the name ZAs (ZAs - Zentrale Erfassungsstelle asbeststaubgefährdeter Arbeitnehmer). The business administration is carried out by the BG for the Energy, Textile, Electrical and Media (BG ETEM) on behalf of the German Social Accident Insurance (DGUV – Deutsche Gesetzliche Unfallversicherung). The aim of the GVS is to register any occupationally asbestos exposed persons and to organize medical surveillance examinations for these persons after cessation of the asbestos exposure, but also during potential exposure to asbestos (HVBG, 1998; GVS). Since the German reunification in 1990 asbestos exposed employees of the former GDR are as well registered at the GVS.
The registration and organisation of medical surveillance of former or current asbestos exposed workers is based on the Law of the German Social Accident Insurance (§ 204 Abs. 1 Nr. 2 Sozialgesetzbuch VII). According to the Law for preventive medical examination (Verordnung zur Arbeitsmedizinischen Vorsorge – ArbMedVV) the employer is responsible for organizing medical examinations when evidence of an exposure to asbestos has been found and the limit value of the asbestos fibre concentration is exceeded (10,000 fibres/m^3) (§ 4 (Pflichtuntersuchungen) ArbMedVV; No. 10 TRGS 519). If the limit value is not exceeded, voluntary examinations have to be offered (No. 10.2 TRGS 517). The employer has to provide former employees, who were exposed to certain hazardous substances containing asbestos during their time working in the company, with follow-up examinations (§ 5 (Angebotsuntersuchungen) ArbMedVV; No. 10.3 TRGS 517). The employer can delegate the duty to organize follow-up examinations to the GVS. These follow-up examinations are offered to workers, who were exposed in the past, given their approval.
Tab. 6.1 shows the total number of workers for the year 2013 who are registered for medical examinations because of asbestos exposure (GVS). This number includes the number of workers (i) who are currently at risk of exposure, and (ii) workers who were previously exposed and to whom follow-up medical examinations are provided. However, the total number does not represent the number of workers ever exposed. The registry is updated on an annual basis including (i) new entries, i.e. newly exposed workers, and (ii) withdrawals, e.g. due to death, renouncing the right of medical examinations, and (iii) diagnosis of an Occupational Disease (OD). Furthermore, it is assumed that employees exposed prior to 1972 are not completely covered to the ZAs.
The number of workers currently registered for medical examinations, because of the risk of exposure, is most likely lower than the number of the workers to whom medi-

cal examinations could be provided by law since it is assumed that not all employers will announce their workers. It is important to note that in 1972, when GVS started to work, malignant mesothelioma were not considered as an occupational disease by law. Thus when the surveillance programme started, the main disease recognized to be associated with asbestos exposure was asbestosis.

Tab. 6.1 Employees registered at GVS for medical examinations because of asbestos exposure and registered enterprises currently involved in working tasks with asbestos-containing materials
(Source: Rundschreiben Gesundheitsvorsorge 1/2013)

	31.12.2009	**31.12.2010**	**31.12.2011**	**31.12.2012**
Total number of workers formerly or currently exposed	545,825	550,554	555,809	**564,927**
Including: Currently at risk of exposure	73,434	75,206	77,318	**88,979**
Enterprises	17,725	17,013	17,230	**17,337**

There is no official number available that includes every worker that has been exposed to asbestos over time. Based on the GVS figure and the experience (of experts) based on research studies on asbestos exposure and related health impacts (e.g. Prof. H.-J. Woitowitz) it has been estimated that up to 2.5 million workers were exposed to asbestos in the past in Germany (NEUMAN et al., 2013). This estimation is approximately five times higher than the number of registry entries of the GVS-register of asbestos exposed of about 560,000.
The majority of workers currently at risk of exposure are working in demolition, reconstruction or maintenance industries involving work on asbestos containing buildings and asbestos waste disposal. The Technical Rules for Hazardous Substances 519 specify the general requirements for the protection of workers and other people according to the Hazardous Substances Ordinance in particular in its annex III No. 2.4 “Supplementary asbestos safety measures“ with the aim to minimize exposure for these kinds of working tasks.
In addition to occupational exposure, non-occupational asbestos exposures which is not covered by the German Social Accident Insurance, may be of relevance with respect to (KONETZKE et al., 1990):

- Relatives of exposed employees may be exposed at home because of coming into contact e.g. with contaminated work clothes, e.g. whilst doing the laundry (Schneider et al., 1996),
- Demolition and/or reconstruction works with asbestos-containing materials at home not compliant with the health and safety rules,
- Asbestos fibre emissions from an asbestos-processing plant and the subsequent exposure of people living in close vicinity,
- Use of asbestos-containing materials in the household.

However, estimates on non-occupational exposure of individuals are not available.

6.2 CAREX (CARcinogen EXposure) Database

The CAREX database provides data on the prevalence of exposure to asbestos. The database provides estimates on the number of workers exposed to carcinogens for 55 industrial sectors based on the United Nations classification system (ISIC Revision 2). The database includes data of 15 member states of the European Union (exposure data 1990 – 1993), whereby four out of the ten member states joined in 2004 (exposure data 1997). Data of 139 carcinogens are included. With respect to Germany it was estimated that **159,250 workers** were exposed to asbestos considering the time period from **1990 to 1993**. The highest estimate of workers exposed was found in the construction industry (73,861), the second highest number in the mining industry (27,739), and the third highest number for Personal and House hold services (36,866).
The estimates are not based on exposure data from Germany, but on exposure prevalence data from Finland and the United States (U.S.). These two countries were considered as reference countries because of the comprehensive set of exposure data available. In the first step the most valid baseline value from one of the two reference countries was selected in order to estimate the exposure prevalence. In the second step, selected experts were invited to modify the first prevalence estimates or to select values based on their expertise. These exposure prevalence estimates were then combined with National workforce data to generate estimates on the number of workers exposed.
Especially due to utilisation of prevalence data from one to another country the uncertainty in the estimates will be very high. In addition, for risk assessments level and duration of exposures is needed to establish exposure-risk relationships. Furthermore, the estimates are outdated. In general, there is a need to update data about the prevalence of those exposed to occupational carcinogens. In sum, the estimates for asbestos exposed workers provided by the CAREX database are very uncertain.

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7 Full list of industries where exposure to asbestos is present in largest numbers of workers potentially exposed to asbestos

The GVS database on exposed employees does not offer a direct breakdown of the the industries where each exposed person works. However, the German social accident insurance is roughly organized according to the main industry sectors. Therefore, the information provided in Tab. 7.1 was used to identify the key industrial sectors with a risk to asbestos exposure. Tab. 7.1 shows that 87% (77,737) of the potentially exposed workers of the BG for building trade, which covers mainly workers of the construction industry. However, the second largest BG for woodworking and metal(working) industry covers a broad range of metal and wood making products having a share of 5%. The third largest fraction of exposed workers belongs to the BG for the transport industry covering the workers in the transport sector (3%).

Tab. 7.1 Workers exposed according to the data from Statutory Social Accident Insurance
(Source: Rundschreiben Gesundheitsvorsorge 1/2013)
*Between 2000 and 2011 several institutions for statutory accident insurance merged. In the brackets the institutions for statutory accident insurance that merged are shown.

Accident insurance within industrial and public sector	Number of workers ever exposed	Currently exposed (31.12.2012)
BG for the raw materials and chemical industry (includes the former BGs for mining, chemical industry, leather industry, papermaking, quarry and sugar)*	109,638	1,665
BG for the woodworking and metalworking industries (includes the former BGs for metallurgical plants and rolling mills, mechanical engineering, woodworking, metalworking)	93,942	4,457
BG for the energy, textile, electrical and media products sectors (includes the former BGs for precision and electrical engineering, textiles and clothing, printing and paper processing, gas, district heating and water management)	79,704	790
BG for the foodstuffs and catering industry (includes the former BGs for foodstuffs and catering industry, and meat trade)	2,320	2
BG for the trade and distribution industry (includes the former BGs for retail sale, wholesale and distribution)	10,634	856
BG for the administrative sector (includes the former BG for the administrative sector, ceramics and glass, tram and railway)	23,045	13
BG for the transport industry (includes the former BG for vehicle operators, maritime)	14,655	2,550

BG for the health and welfare services	2,214	53
BG for the building trade	105,882	77,737
Accident insurance in agricultural sector	5,076	363
Accident insurance in public sector	10,372	493
Old cases from former GDR	107,445	
Sum	**564,927**	**88,979**

8 Industries with high risk of exposure (where overexposure is documented as exceeding exposure limits) and estimated total number of workers at high risk

Not relevant: no high risk of exposure

9 Estimate of the burden of diseases related to asbestos: disability adjusted life years (DALY/PLYY) and deaths attributable to asbestos exposure

9.1 Deaths attributable to asbestos exposure

Asbestosis and pleural diseases, lung cancer or cancer of the larynx and malignant mesothelioma are important causes of mortality, especially with respect to occupational mortality.
Fig. 9.1 shows the relative shares of the six occupational diseases (OD) associated with the highest number of deaths in 2012. The largest share is represented by mesothelioma (34%), the second largest share by asbestos caused lung cancer (24%), and the fifth largest share by asbestosis (4%). In sum, the OD attributable to asbestos account for 62% of total OD deaths. This trend was observed to be quite stable over the last years and is expected to continue for the next years.

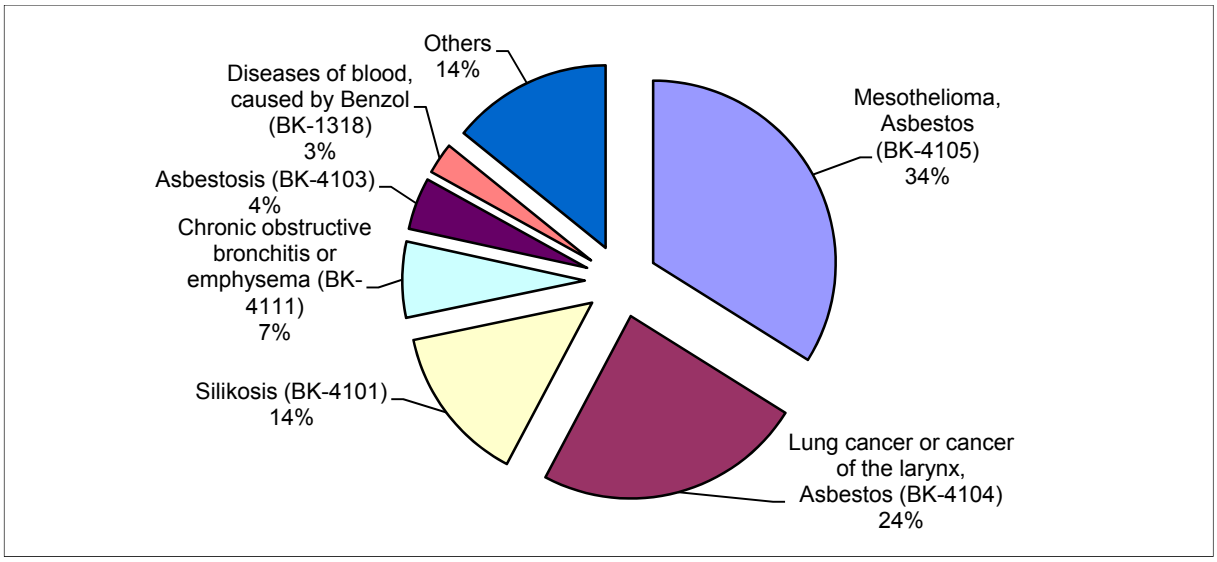

Fig. 9.1 Overview on fatalities due to occupational diseases [%], 2012 (Source: DGUV, 2013)

Data on deaths attributable to asbestos were provided by the **German Statutory Accident Insurance** (DGUV) (see Table 9.1). These data cover deaths due to recognized occupational diseases (OD). However, asbestos exposure can also prevail outside of the occupational working environment, for example, due to demolition work at home, the handling of asbestos containing materials in the private environment or due to weathering and erosion of roofs containing asbestos. However, reliable estimates of a general mortality risk attributable to asbestos outside the occupational situation are not available. Due to possible non-occupational asbestos exposure, the reported numbers on occupational deaths caused by asbestos may underestimate the total disease burden to asbestos exposure (occupational and non-occupational) to an unknown degree. However, the ubiquitous background exposure to asbestos

for Germany is considered as low (Hagemeyer et al., 2006); therefore, one may assume that the degree of the underestimation may be low.

Tab. 9.1 Deaths attributable to occupational diseases OD No. 4103, 4104, 4105, 4114
(Source: Geschäfts- und Rechnungsergebnisse, DGUV, 2013)
*Calculation conducted by the author(s)

Occupational diseases (OD)	**OD No.**			
	4103	**4104**	**4105**	**4114**
Deaths*	**Asbestosis**	**Lung cancer/ larynx cancer, Asbestos**	**Mesothelioma, Asbestos**	**Lung cancer, Asbestos, and PAH**
1994	82	484	406	
1995	78	583	489	
1996	103	674	517	
1997	59	652	564	
1998	93	644	539	
1999	72	708	594	
2000	75	623	645	
2001	73	683	682	
2002	88	707	676	
2003	96	684	703	
2004	113	676	753	
2005	74	711	812	
2006	113	583	746	
2007	84	601	740	
2008	95	591	793	
2009	112	513	747	1
2010	102	497	694	3
2011	131	581	759	9
2012	113	585	832	13
Sum*	**1,756**	**11,780**	**12,691**	**26**
Total Sum				**26,253**

Tab. 9.2 provides an overview of the key indicators of asbestos caused occupational cancer cases:

Tab. 9.2 Key Indicators of asbestos cancer cases
(Source: DGUV, 2012)
(For the calculation of the standard deviation a normal distribution of the indicators is assumed. E.g., if the mean age of diagnoses is 70 years and the standard deviation is 10 years, then 95% of the mortality incidence would occur between an ages of 50 to 90 years.)

Occupational diseases (OD)	**OD No.**		
	4104	**4105**	**4114 (since 2009)**
Key indicators of asbestos related diseases - Mean values [Standard deviation]	**Lung cancer/ larynx cancer, asbestos**	**Mesothelioma, asbestos**	**Lung cancer, asbestos, and PAH**
Mortality ratio (Deaths/Cancer cases)	82.2%	90.3%	61.6%
Exposure time	20.1 [12.8]	17.7 [13.3]	22.2 [16.9]
Latency period	37.3 [20.3]	38.4 [16.2]	41.3 [18.5]
Age at diagnosis	66.9 [8.5]	67.1 [9.6]	69.9 [9.1]
Time span Diagnosis – Death	1.8 [2.9]	1.4 [1.8]	0.6 [0.7]

With regards to the reliability of the data to give a realistic impression on the disease/ mortality burden of asbestos exposure at the workplace there may be a substantial degree of underreporting and therefore an underestimation of the risk/health impact. Most likely a certain degree of underreporting will prevail, but being difficult to estimate (BRÜSKE-HOHLFELD, 1999; HAGEMEYER, 2006). Reasons for underreporting are difficulties in diagnosing asbestos related diseases. In addition, no or late notifications to the institutions of the statutory accident insurance were reported with respect to the case of mesothelioma (OD No. 4105) (KOCH, 1989). The process of recognition especially for OD No. 4104 (lung cancer, Asbestos), and OD No. 4114 (lung cancer, Asbestos and Polycyclic Aromatic Hydrocarbons (PAH) in many cases requires a robust estimate on the cumulative asbestos exposure. Due to the long latency of the disease of more than 30 years assesignment of past exposure levels over the entire working life is a complex task (DGUV, 2013).
Based on the death statistics of the German Federal Statistical Office and the **Federal cancer registers** lung-cancer deaths and mesothelioma deaths are reported by the German Centre for Registry Data located at Robert Koch Institute[9]. Because lung cancer can have several causes that are difficult to disentangle with respect to the diagnosis of asbestos caused lung cancer and otherwise caused lung cancer, these data are not directly usable. This is different for **mesothelioma** (C45, ICD-10). Asbestos exposure at the workplace is considered as the main cause of this disease (e.g. HVBG, 2003; HAGEMEYER 2006). Thus the reported fatalities are considered to be mainly attributable to asbestos exposure at the workplace.

[9] www.krebsdaten.de

Therefore, data on (i) asbestos caused deaths can be utilized from the following source: data from the DGUV on occupational diseases are reported here (see Table 9.1), and, in addition, (ii) data on mesothelioma deaths (cases, and mortality rates) can be utilized from the following source: the German cancer register (see Figure 9.2, Table 9.3). An aggregated figure on mesothelioma deaths was reported for the first time in 2013 as not all of the Federal cancer registries provided data on mesothelioma (ICD-10, C45) in the previous years:

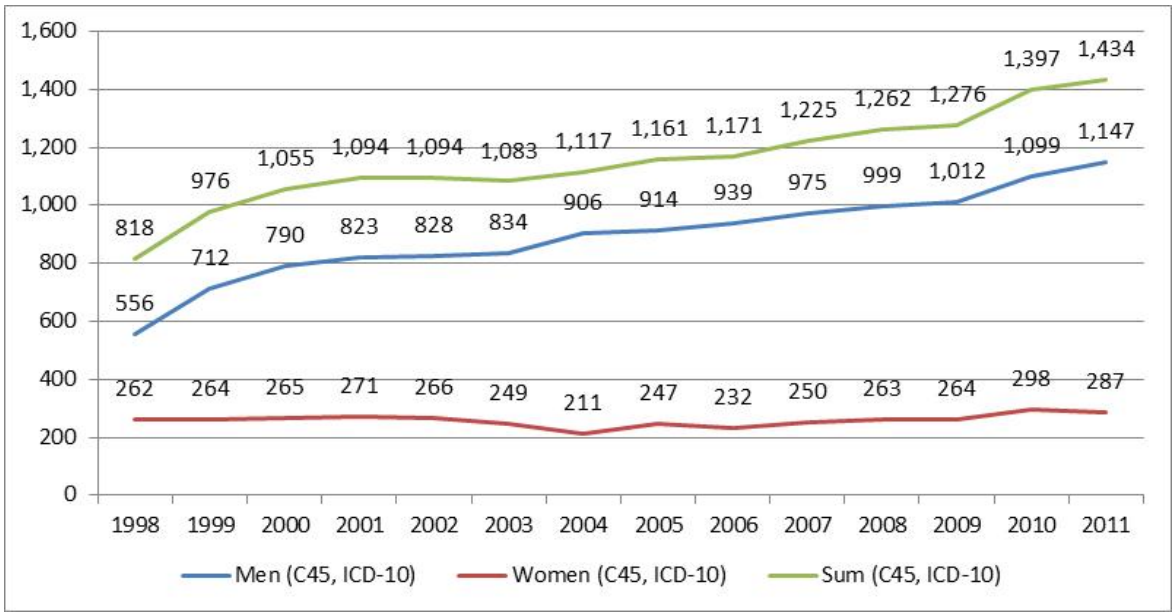

Fig. 9.2 Mesothelioma deaths – women and men
(Source: Federal Statistical Office, German Centre for Cancer Registry Data/ Robert-Koch Institute)

9.2 Potential Years of Life Lost (PYLL) attributable to asbestos exposure in Germany

Tab. 9.3 Estimated potential years of life lost attributable to OD No. 4103, 4104, 4105, 4114
(Source: ODs Documentation, DGUV, 23 April 2014; calculation conducted by the author(s))

	Potential Years of Life Lost (PYLL)				
	Asbestosis, OD No. 4103	**Lung cancer/ larynx cancer, Asbestos, OD No. 4104**	**Mesothelioma, Asbestos, OD No. 4105**	**Lung cancer, Asbestos, and PAH (since 2009), OD No. 4114**	**Sum**
1990 – 2000	7,729	74,144	69,344		151,217
2001	733	8,568	8,834	-	18,135
2002	823	8,842	9,078	-	18,743
2003	801	8,899	9,958	-	19,658

2004	1,164	9,308	10,044	**-**	20,516
2005	872	10,480	12,055	**-**	23,407
2006	1,142	8,685	11,688	**-**	21,514
2007	1,133	8,932	11,097	**-**	21,163
2008	1,213	8,932	11,757	**-**	21,902
2009	1,241	7,517	11,024	32	19,813
2010	1,099	7,199	9,677	54	18,029
2011	1,224	8,027	10,528	134	19,913
2012	1,123	7,975	10,570	216	19,885
Sum PYLL	**20,296**	**177,509**	**195,655**	**436**	**393,895**
Annual average of PYLL [Sum PYLL/No. of reported years]	882	7,718	8,507	109	
Average Potential Years of Life Lost (APYLL) [PYLL/No. of deaths]	10.5	14.1	14.3	15.6	**13.9**

To estimate the burden of disease attributable to asbestos related diseases the indicator “Potential years of life lost” (PYLL) is used. Calculation of this indicator is based on the estimation of the number of years a premature death occurred earlier than it would have occurred naturally in the absence of the asbestos related disease. The calculation follows the simplified guideline for calculating of PYLL provided at WHO capacity building workshop 16th-18th October, Bonn (PARK, 2013). The aggregated number of PYLL does not contain a discounting of PYLLs over time or a weighting of PYLLs for different age groups.
In detail, the PYLL calculation is based on

- Deaths attributable to asbestos exposure in the following age groups:
  - Men: 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-80, 80+ (BK-DOK, 23 April 2014)
  - Women: 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-80, 80+ (BK-DOK, 23 April 2014)
- Life expectancy of the age groups of deaths for Germany for the years 2011, 2000, 1990 (WHO Health Statistics, World Health Organization, 2012); life expectancy for the years in between are generated by interpolation.

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10 Prevalence of asbestosis (total number of workers with diagnosed asbestosis, asbestos-related lung cancer and mesothelioma to-date) – national data, a breakdown

10.1 Occupational diseases (OD)

This section aims to briefly explain the current practice of the institutions of statutory accident insurance with respect to the recognition of OD caused by asbestos exposure.
Certain conditions of health are formally recognized as occupational diseases, if it can be proven that the disease developed as a result of exposure to health hazards at the workplace at a higher level compared to the general population, i.e. due to work related activities covered by the insurance. Formally recognized occupational diseases are summarized on the list of occupational diseases issued by the German government with the approval of the upper chamber. Other diseases may also be recognized as being of occupational origin, if new medical/scientific findings prove that they meet the criteria for inclusion on the list of formally recognized occupational diseases.
Appendix 1 of the German Occupational Diseases List currently lists four asbestos-related diseases:

- BK 4103 – Asbestosis or diseases of the pleura caused by asbestos dust
- BK 4104 – Lung or larynx cancer
    - combined with asbestosis,
    - combined with diseases of the pleura caused by asbestos dust or
    - if there is evidence of cumulative exposure to asbestos dust in the workplace of at least 25 fibre years {25 x 10^6 [(fibre/m^3) x years]}.
- BK 4105 – Mesothelioma of the pleura, the peritoneum or the pericardium caused by asbestos.
- BK 4114 – Lung cancer caused by simultaneous exposure to asbestos fibre dust and polycyclic aromatic hydrocarbons, if there is evidence of exposure to a cumulative dose corresponding to a causative probability of at least 50% according to annex 2 of the Berufskrankheitenverordnung (BKV) (since 2009).

If the death is caused by an OD, widows/ widowers and orphans receive a pension. However, providing the (scientific) evidence that the premature death was caused by asbestos exposure may prove to be difficult. This applies especially to OD, like lung cancer, for which in principle several causes can be identified. As a consequence, for occupational fatalities a legal presumption of a reduction of the earning capacity of 50% and that the death is caused by the OD (No. 4103, No. 4104) is applied. This applies as long as it is not evident that the death is not caused by the OD. It is not allowed to require an official autopsy to determine if the OD can be assumed to be caused by asbestos.

In order to claim workers' compensation of **lung cancer** (No. 4104) radiological evidence of lung asbestosis or pleural disease has to be provided. Since 1993 lung cancer cases were also compensated, if occupational exposure was at least that of

25 fiber-years. Lung cancer or cancer of the larynx in combination with asbestosis / minimal asbestosis, or pleural plaques or a cumulative asbestos dose of 25 fibre-years at the workplace are defined as occupational disease No. 4104 (DGUV, 2011; FISCHER, 2002). Fibre-years are used as rough parameter in occupational medicine for the intensity of asbestos exposure at the workplace. They are defined as the product of (i) the concentration of asbestos-fibres longer than 5µm, diameter < 3 µm, ratio length: diameter > 3:1 at the work-place, (ii) the time of exposure and (iii) the duration of exposed work-time (1 x 10^6 fibres/m^3 x years). Additional symptoms of asbestosis were no longer a prerequisite, which made compensation of lung cancer easier (BRÜSKE-HOHLFELD, 1999; KARABIN-KEHL et al., 2002).
Due to the fact that specific data from former work-places are often missing, the commission of the German insurance institutions utilizes a calculation model (DGUV, 2013). The model contains an evaluation of the length of employment and latency of exposure by an expert. The research institutions usually assume the “worst-case conditions” for the exposure estimation, which must not be realistic. Furthermore, the model considers fibre-doses independent from exposure conditions, for example a dose of 25 fibre-years can be the product of an exposure of 25 x 10^6 F/m^3 over one year or of 10^6 F/m^3 over 25 years (FISCHER, 2002). The use of fibre-years as a rough indicator of cumulative asbestos exposure is based on evidence from occupational medicine and epidemiology of a linear concentration-response relationship between cumulative asbestos exposures and lung cancer. The risk of lung-cancer is assumed to double for an exposure of 25 fibre-years (Merkblatt BK-Nr. 4104, provided by Ärztlicher Sachverständigenbeirat "Berufskrankheiten" at Federal Ministry of Work and Social Affairs). The estimated fibre-years are a crucial part of the final judgment, if the disease will be recognized as an OD to assume an occupational disease.

Mesothelioma is recognized as an OD (No. 4105), if histological proof can be provided and asbestos exposure has been proven. As mesothelioma may be caused by very low asbestos exposure no threshold value for the recognized OD has been defined (BAUR, 2011; DGUV, 2011, 2013; KARABIN-KEHL et al., 2002). Criteria for the differentiation between occupational and non-occupational exposure (environmental) are not defined as environmental exposure is considered to be very low and hence negligible compared to occupational exposure.

Asbestosis or pleural disease is recognized as an OD (No. 4103), if lung fibrosis and pathological modifications of the pleura have been diagnosed and a sufficient asbestos exposure corresponding to the severity of the disease prevails. However, a threshold for exposure cannot be defined. For recognition of pleura disease as OD asbestos exposure above environmental exposure is sufficient (DGUV 2011; BAUR, 2011).

Lung cancer caused by interaction between asbestos fibre dust and polycyclic aromatic hydrocarbons (PAH) has been added to the OD-list (No. 4114) in 2009. The procedure of recognition of this disease is similar to the one of OD No. 4104 (Lung cancer). The additive relationship (syncancerogenesis) between asbestos and PAH has been confirmed by findings of experimental and epidemiological studies. With respect to the recognition of this disease lung cancer has to be diagnosed, and a cumulative asbestos and PAH exposure has to be proven, to which a probability to cause lung cancer of at least 50% can be attributed (DGUV, 2011, 2013). In addition,

to the concept of fibre-years the concept of Benzo[a]pyrene-years is applied (BaP-years). BaP-years comprise the product (i) of PaP exposure (µg/m^3) and (ii) duration of the exposure (years) (µg/m^3 x years). One BaP-year is defined as an exposure of 1 µg/m^3 Benzo[a]pyrene during an 8-hour working shift per day over a time period 240 days per annum. If a cumulative asbestos exposure of ≥25 fibre-years and a cumulative PAH exposure of ≥100 BaP-years has been proven, a causative probability of 50% is confirmed. The calculation of causative probabilities for combinations of fibre-years and BaP-years below these extreme values is based on an additive risk-model.

10.2 Asbestos consumption and recognized occupational diseases

Fig. 10.1 shows the correlation between the development of asbestos consumption and the number of recognized asbestos caused ODs with a mean latency of about 38 years:

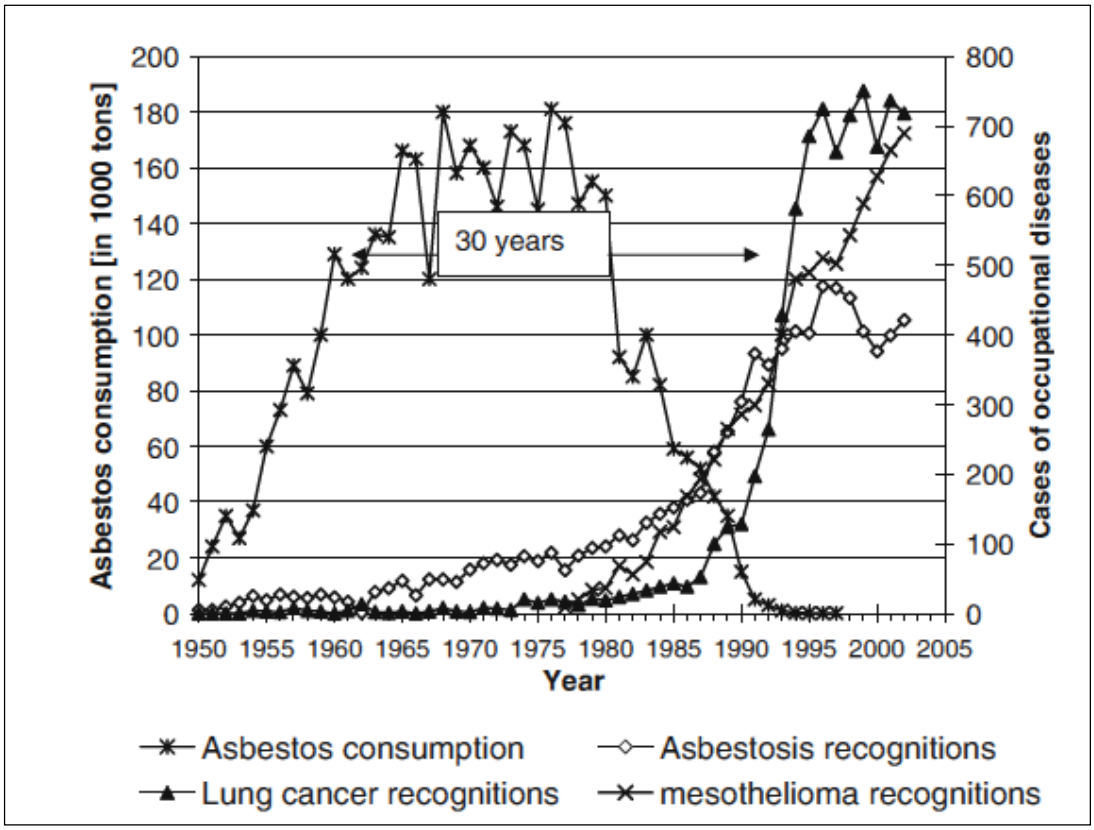

Fig. 10.1 Asbestos consumption and occupational diseases with financial compensation due to asbestos in Germany
(Source: HAGEMEYER et al., 2006; see also BREUER, 2005)

Figure 10.1 shows the development of asbestos consumption in the **former GDR** and the development of recognition of asbestos caused ODs in Eastern Germany before and after the German unification.

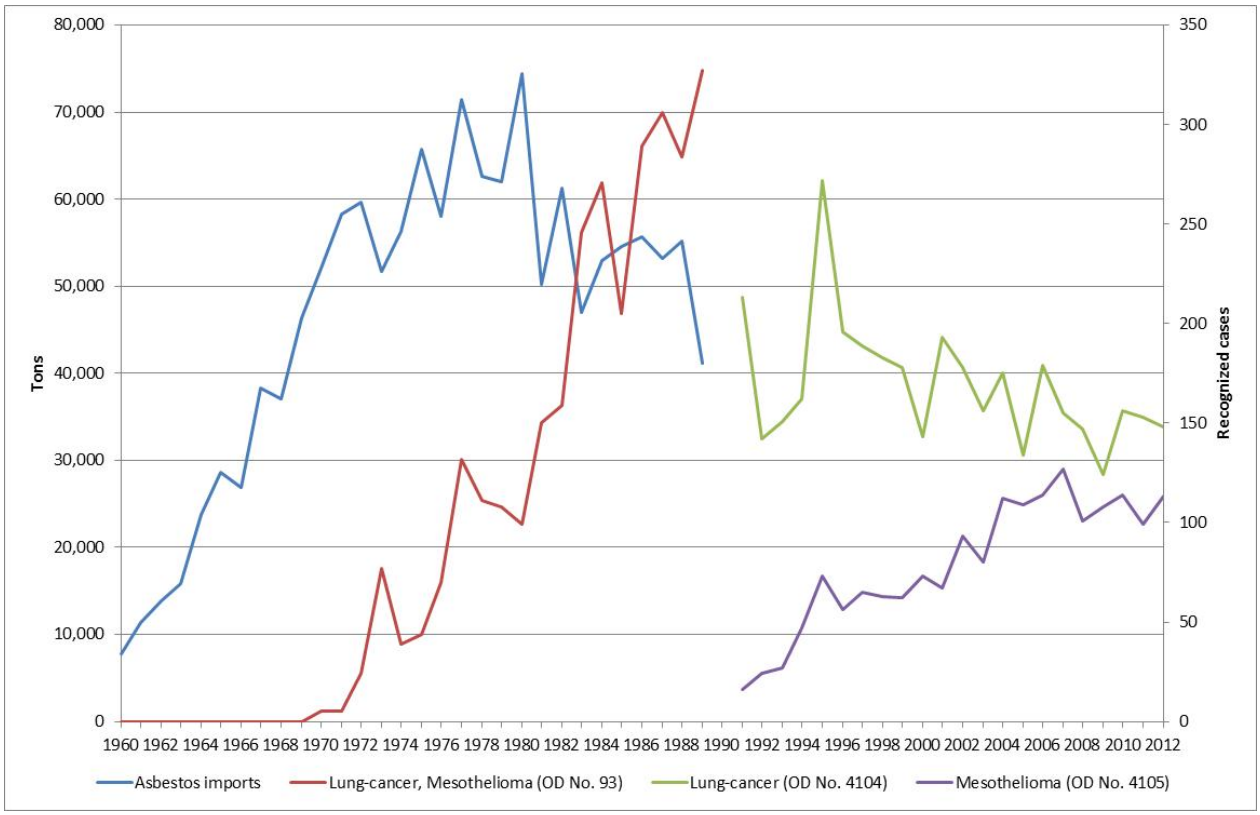

Fig. 10.2 Asbestos consumption and recognized occupational diseases due to asbestos in Eastern Germany before and after German unification (Source: DGUV, 2013)

After the German reunification asbestos imports and consumption in the former GDR stopped abruptly. Before the German reunification (i.e. prior to 1990) lung-cancer and mesothelioma ODs were recognized by the former Social accident insurance of the GDR as one category of ODs (OD No. 93). After the German reunification and the shift to the Social accident insurance system of Western Germany mesothelioma and lung-cancer were separately recognized as OD No. 4105 (mesothelioma) and OD No. 4104 (lung cancer). According to Figure 10.2 for OD No. 4105 (Mesothelioma) an increase in the recognized cases can be observed. For the recognized cases of OD No. 4104 (Lung-cancer) a convergent trend to about 150 ODs per year was observed. Given a latency period between 30 and 40 years the cases may be mainly attributed to asbestos consumption in the former GDR between 1960 and 1980.
Until 2012 about **70,000 cases** caused by asbestos exposure were recognized by the institutions of the statutory accident insurance as Occupational Diseases:

Tab. 10.1 Recognized cases of asbestos related occupational diseases (Source: ODs Documentation, DGUV, 24 September 2012; 20 December 2013)

Occupational diseases (OD)	**OD No.**			
	4103	**4104**	**4105**	**4114** (since 2009)
Recognized cases	**Asbestosis**	**Lung cancer/ larynx cancer, Asbestos**	**Mesothelioma, Asbestos**	**Lung cancer, Asbestos, and PAH**
1980 – 2012	40,130	16,313	17,143	55
Total Sum				**73,641**
2012	1,846	806	975	19

Fig. 10.3 shows the development in the recognition of ODs from 1980 onwards showing a considerable increase in the sum of recognitions in 1991:

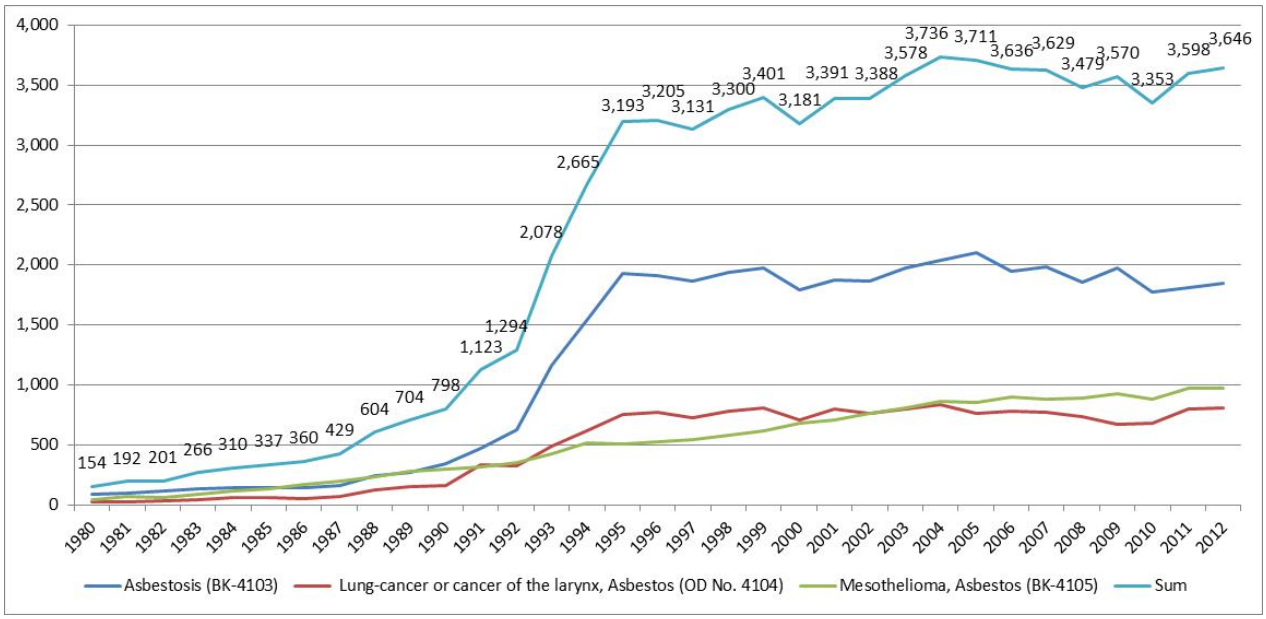

Fig. 10.3 Recognized cases of occupational diseases caused by asbestos (OD No. 4103, 4104, 4105)
(Source: ODs Documentation, DGUV, 24 September 2012; 20 December 2013)

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11 Incidence of lung cancer among workers exposed to asbestos

Asbestos caused lung cancer is not different to lung-cancer from other causes, for example cigarette smoking. Therefore, estimating the new cases (incidence) of asbestos caused lung-cancer is more difficult regarding their aetiology than for mesothelioma and asbestosis. In order to recognize lung-cancer as an OD No. 4104 the demonstration of asbestosis, and since 1993 alternatively a cumulative exposure to asbestos of at least 25 fibre-years are a prerequisite for confirming the OD case (VAN KAMPEN et al., 2008).
Fig. 11.1 shows the development of the cases of lung/ larynx-cancer recognized by DGUV as ODs. Expressed as the rate of cases per 100,000 full-time employees (FTE) , prior to 1985 the rates were below until 0.02 cases per 100,000 FTE, and then a sharp increase was observed until 2005 up to 8 cases per 100,000 FTE (VAN KAMPEN et al., 2008).

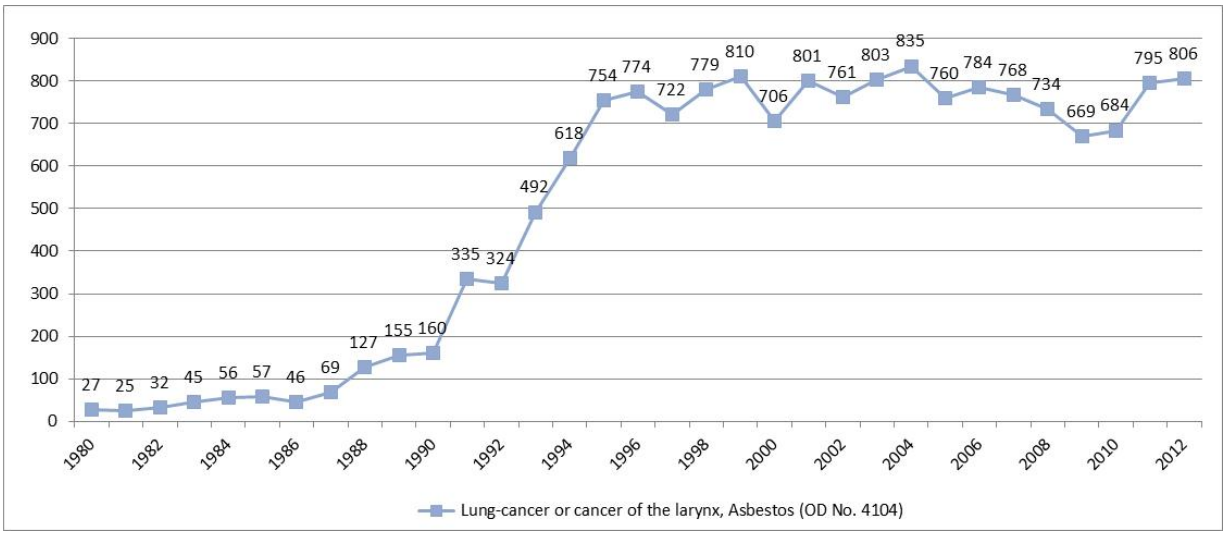

Fig. 11.1 Recognized cases of OD No. 4104 (Lung cancer and cancer of the larynx)
(Source: ODs Documentation, DGUV, 24 September 2012; 20 December 2013)

Since the ban of asbestos in 1993 in Germany, the incidence of asbestos lung cancer can be mainly attributed to asbestos exposure 30 to 40 years ago. The number of recognized cases gives an indication of the incidence of lung-cancer caused by asbestos in the population. However, due to non-occupational asbestos exposure, the number of recognized cases are not representative for an entire population and will most likely underestimate the total incidence of lung-cancer to an unknown degree.
Therefore, one way to estimate the incidence of lung-cancer caused by asbestos exposure is to estimate the incidence of lung-cancer by asbestos exposure and to estimate the relative risk (RR) of lung-cancer incidence in relation to asbestos exposure for a specific dataset. In a second step the concentration-response function (based on scientific evidence from a conducted research study, or the literature) is used to estimate the lung-cancer incidence for the entire population by using as data input representative exposure estimates for the population. Several case-control and co-

hort studies on the relative risk of asbestos exposure are available for Germany (see for example AHRENS et al., 1993; BRÜSKE-HOHLFELD, 2000; JÖCKEL et al., 1998; VAN KAMPEN et al., 2008; WOITOWITZ et al., 1986). However, this rather complicated approach of health risk assessment for the estimation of asbestos lung-cancer incidence was not chosen for this report mainly due to missing or inconsistent data on prevalence of exposure levels.

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12 Incidence of mesothelioma

Since 1977 pleural and peritoneal mesothelioma are on the official list of occupational diseases of the German statutory accident insurance (OD No. 4105). In 1992 the pericardial mesothelioma was included as well in this OD. 97% of the cases are pleural mesothelioma (LEHNER et al., 2007). Epidemiological studies show a strong correlation between asbestos exposure and mesothelioma (NEUMANN et al., 2012; PETO et al., 1999; PARK et al., 2011). The percentage of mesothelioma cases that are not associated with asbestos is estimated to range from 10% to 20% (NEUMANN et al., 2012). Another substance apart from asbestos that may cause mesothelioma is zeolite (erionite), which is a type of asbestos like mineral fibre (NEUMANN et al., 2012). Thus about ≥80% of the mesothelioma cases are caused by asbestos exposure, mainly at the workplace. As very low asbestos exposures may cause mesothelioma, no threshold level is applied to get the disease recognized as an OD (HVBG, 2003; DGUV, 2013). Thus criteria for differentiation between occupational and non-occupational exposure (ubiquity) are not defined.
An analysis of statistical data on occupational diseases by the DGUV for the time period of 1978 to 2010 showed for 13,724 mortality cases that: (i) the average latency period is approximately 38 years, (ii) the mean age of the diagnosis is 67 years, and (iii) the mean time between diagnosis and death is 1.4 years (DGUV, 2012) (see Tab. 9.2 above). The stratification of the results by gender showed that the overwhelming majority of the cases (94%) were men.

European trends for the development of mesothelioma were predicted based on observed trends in male pleural cancer mortality in Britain and six other European countries (PETO et al., 1999). The model used available age specific death rates for the time period from 1970 to 1989 to predict the number of pleural cancer deaths from 1995 to 2029. Study results showed in Germany the occurrence of a peak from 2015 to 2019. In a more recent journal article, that included the mortality data of the time period 1995–1999 into the model, it was shown that the predicted deaths for this time period in PETO et al. (1999) were slightly overestimated. Therefore the peak is assumed to occur a number of years earlier than estimated by PETO et al. (2015 to 2019); in the Western European Countries most likely between 2003 and 2013 (PELUCCHI et al., 2004).

The following figures and tables show the **new cases and the incidence of mesothelioma** (new cases/100,000) for men and women in Germany and in each of the Federal states of Germany for the time period 2001 to 2010. The reporting on the incidence of mesothelioma is based on the **Federal Cancer Registry** of the Federal states. The reporting system on mesothelioma varied considerably between the individual Federal states. Aggregated numbers on new mesothelioma cases and incidence were provided for the first time in 2012 by the German Centre for Cancer Registry Data at the Robert-Koch Institute (RKI). The report also showed that incidence numbers for Hamburg and Bremen are considerably higher than for the rest of Germany.

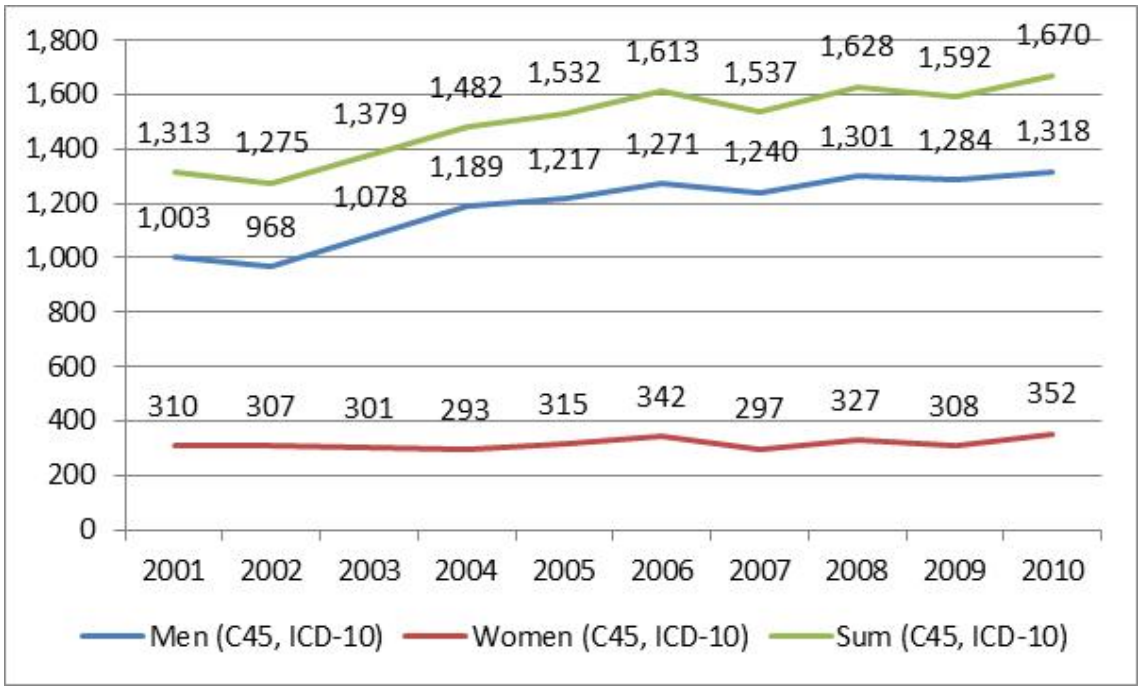

Fig. 12.1 New cases of malignant mesothelioma
(Source: German Centre for Cancer Registry Data/Robert-Koch Institute)

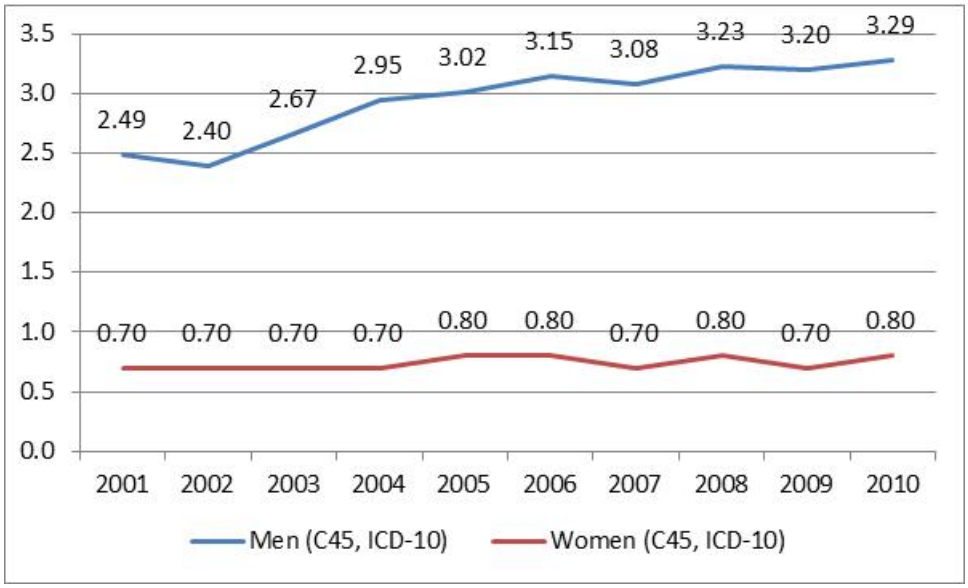

Fig. 12.2 Incidence of malignant mesothelioma (New cases/100,000)
(Source: German Centre for Cancer Registry Data/Robert-Koch Institute)

There is some controversy on the contribution of chrysotile to the development of the mesothelioma epidemic. The cancerogenous potency of amphibole asbestos, especially of crocidolite, is considered to be higher than that of chrysotile (PETO et al., 1999; KARABIN-KEHL et al., 2013). However, there are a number of documented cases where mesothelioma was caused most likely by pure chrysotile. In addition, it

can be assumed that chrysotile usually contains impurities of amphibole fibres (IARC, 2012).
After the German reunification the Office of Occupational Hygiene in Magdeburg has published data on Mesothelioma cases analysed between 1960 and 1990 in the chemical industry in the region of Magdeburg and Leuna/Halle (3 M. inhabitants) of the **former GDR**. The data were provided by the head of the department for dust-induced diseases after the German reunification (Dr. Sturm, and his successor Dr. Menze) (STURM et al., 1994). In total 843 mesothelioma cases were evaluated, 812 with complete and secured data on exposure and clinical data. In 414 of these cases amphibole exposure was proven to have occurred (135 + 279). In 67 cases strong evidence for only chrysotile exposure was provided. Thus these data provide some evidence that chrysotile asbestos also caused mesothelioma. Almost all imports of asbestos were chrysotile asbestos from Russia.

Tab. 12.1 Mesothelioma cases according to exposure to different types of asbestos
(Source: adapted from STURM et al., 1994)

	Amphibols only	**Amphibols & Chryso-tile (certain)**	**Chrysotile (certain) & Amphibols (uncertain)**	**Chrysotile only**
Cases	135	279	331	67

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13 Estimates on the percentage of house stock and vehicle fleet containing asbestos

13.1 House stock

The main application area of asbestos with respect to buildings was asbestos cement. On average 70% of the total imports of the FRG and the GDR is estimated to be used for asbestos cement products[10] (strongly bound, BBSR, 2010) adding up to 4.3 M. tons of asbestos. Given that these products contain 10% of crude asbestos, about **43 M. tons of asbestos cement** is estimated to be produced from the asbestos imported between 1950 and 1990.

Tab. 13.1 Estimated tonnage of asbestos cement products
**This sum will be overestimate asbestos cement since also before 2001 some asbestos waste disposal has prevailed.

Import of asbestos (GDR & FRG):	5.7 M. tons
70% used for asbestos cement production:	3.99 M. tons
Asbestos cement production (10% crude asbestos):	39.9 M. tons
Asbestos waste disposal: asbestos containing building materials (17 06 05*):	4.18 M. tons (2001 – 2011)
Asbestos cement - remaining**	35.7 M. tons (2011)

The estimated volume of asbestos cement products after subtracting asbestos containing building material disposal (for the results of the calculation see table above) is used to estimate the roof area containing asbestos: The mean weight of corrugated roofs are estimated to be approximately 20kg per m^2. Thus, if one assumes that 25% of the asbestos cement is used for corrugated roofs, there will be **447 M. m^2 (7%)** corrugated roofs, and **893 M. m^2 (15%),** if 50% of the asbestos cement is used for roofs, and **1,340 M. m^2 (22%),** if 75% is used for roofs. The percentage values in brackets show the percentage share of the estimated corrugated roofs containing asbestos of the total roof area in Germany (about 6,000 M. m^2).

The Bavarian Environmental Protection Agency provided an estimate of about 900 M. m^2 for roofs containing asbestos, including 300 M. m^2 of uncoated roof surface in the former **FRG.** With respect to the **former GDR** it is assumed that about 80% of the crude asbestos imports were used for asbestos cement products. Based on this assumption about 85% were applied in the construction industry, and about 10% were exported. It was estimated that from 1960 onwards a roof surface area of about 500

[10] The share of asbestos imports which were used for asbestos cement pipes (about 21% in former GDR (UBA, 1990) is excluded here.

M. m^2 asbestos cement sheets was built (mainly uncoated) (UBA, 1990; BAYERISCHES LANDESAMT FÜR UMWELT, 2008). The most important product names of asbestos cement used for corrugated roofs included „Eternit®“, “Fulgurit®“ until 12//1991 in FRG, and „Baufanit“ in GDR up to 1989. The Sokalit®“ asbestos cement sheet containing (weakly bounded) asbestos was commonly used for construction.

13.2 Vehicle fleet

As a result of the ban of asbestos in 1993 the use of asbestos for brake pads and clutches for the production of new vehicles on the roads in Germany was prohibited. Due to the nearly complete renewal of the vehicle fleet over a time span of about 20 years, it is expected that asbestos will have disappeared nearly completely from the vehicle fleet today.
In West-Germany the automotive industry started already to switch to asbestos-free brake pads for new cars in the mid-1980s. With some lag time the car repair workshops also switched to the use of asbestos-free material for vehicle repairs. In the former GDR production of asbestos containing brake pads and their use continued until 1989/90.

13.3 References

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14 Total number of workers eligible for compensation for asbestos-related diseases, such as asbestosis, lung cancer and mesothelioma (per year) and the annual numbers of individuals compensated

Table 14.1 shows the granted ODs pensions for the asbestos caused ODs from 1975 up to 2012. Before 1975 only a few asbestos ODs were officially recognized, because 30 to 40 years ago (mean latency time) asbestos consumption was very low compared to the high levels of asbestos consumption during the 60's and 70's.
In general, a pension is granted to insured individuals, if their earning capacity has been reduced by at least 20% for over a time period of 26 weeks. In the event of complete loss of the earning capacity, the full pension comprises two-thirds of the gross annual earnings prior to the occupational disease. Where the earning capacity is partly reduced, the pension corresponds to the level of reduction, for example one-third of the previously received gross earnings in the case of a 50% reduction in earning capacity. The accident insurance institutions continue to pay a pension for the entire time period as long as the earning capacity remains reduced, i.e. under certain circumstances for life, irrespectively of whether a new occupation is pursued. In the event of death, the accident insurance institutions are obliged to pay the following benefits to the surviving dependants in particular:

- Death benefit
- Transportation costs
- Surviving dependants' pensions (to which the widow, widower, orphaned children, and under certain circumstances former spouse, relatives in the ascending line, step-parents and foster-parents of the deceased are entitled) (DGUV, 2013b).

Tab. 14.1 New OD Pensions
(Source: Sicherheit und Gesundheit bei der Arbeit – Unfallverhütungsbericht Arbeit 2010, 2012; DGUV, Geschäfts- und Rechnungsergebnisse calculation conducted by the author(s))
*DGUV, 2011; **SUGA, 2012; ***DGUV, 2013a

Occupational diseases (OD)	**OD No.**			
	4103	**4104**	**4105**	**4114**
New OD pensions	**Asbestosis**	**Lung cancer/ larynx cancer, Asbestos**	**Mesothelioma, Asbestos**	**Lung cancer, Asbestos, and PAH (since 2009)**
1975 – 2000**	6,426	6,289	6,723	
2001**	407	770	705	
2002**	438	754	722	
2003**	401	757	780	
2004**	417	800	867	
2005**	429	742	856	
2006**	393	767	920	
2007**	407	752	891	
2008**	410	708	922	
2009**	443	643	929	1*
2010**	423	676	876	14***
2011***	499	736	902	16***
2012***	554	759	906	16***
Sum	**11,647**	**15,154**	**17,004**	**47**
Total sum				**43,852**

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15 National enforceable occupational exposure limits to asbestos

Work procedures defined as low-exposure work should not exceed an exposure level of a fibre-concentration of **10,000 fibres/m^3** for working without respiratory protection and medical surveillance (2018 at the latest: **1,000 fibres/m^3**). The limit value **10,000 fibres/m^3** is called **acceptable risk** level, which is derived by a new risk concept for carcinogenic substances developed by the Committee for Hazardous Substances (BAuA, 2013). A fibre concentration of 10,000 fibres/m^3 is associated with an excess risk of lung-cancer or mesothelioma assuming a workplace exposure for a time period of over 40 years, with 240 working days per year, and exposure duration of 8 hours per day (Announcement 910 Asbestos, 2008). The upper limit, the **tolerable risk,** has been set at a concentration (threshold) of **100,000 fibres/m^3** (Announcement 910 Asbestos, 2008).
The limit value of this additional risk is not associated with a specific substance, but with respect to activities involving carcinogenic hazardous substances. Two risk levels are derived defining three ranges of exposure:

Acceptable risk: (interim limit) 4 : 10,000

(not later than as of 2018) 4 : 100,000.

An exceedance of the limit values can only be tolerated, if the health risks associated with the exposure are adequately controlled by means of risk management measures complying with the specifications outlined in the catalogue of measures.

The second risk limit adopted is the

Tolerable risk: 4 : 1,000

above which a risk is intolerable. The risk refers to a working lifetime of 40 years with a continuous exposure on every working day of 8 hours.

The **acceptable risk** defines the additional cancer risk that is accepted meaning that, statistically, 4 out of 10,000 persons exposed to the substance throughout their working life will develop cancer. The risk does not require any additional protective measures by law, due to the low remaining occupational substance-associated cancer risk. In contrast to that, employees should not be exposed to concentrations above the threshold set by the tolerable risk. The two thresholds differentiating between three different concentration ranges based on the tolerability of the magnitude of the response (cancer cases) proposed by these definitions are in line with the ongoing national and international discussion and open up the possibility of a concept of appropriately graduated measures (Announcement 910, 2008). The **tolerable risk** defines the additional cancer risk of 4 : 1,000 that is tolerated, meaning that, statistically, 4 out of 1,000 persons exposed to the substance throughout their working life will develop cancer. In the case of activities in the range of medium risk (below tolerable risk, but above acceptable risk) exposure must be continuously reduced. The risk concept lists a detailed catalogue of appropriate measures (BAuA, 2013).

The limit value of **10,000 fibres/m^3** (acceptable risk) is used in the **TRGS 517** (Activities with mineral raw materials potentially containing asbestos and preparations and articles manufactured from them) to define requirements for the use of technical safe-

ty and organisational safety measures (No. 4 TRGS 517: General protective measures; No. 4.11/ 4.12: Organisational measures); No. 4.11/ 5.7.2.3: Respiratory protective measures; No. 5.1.2/ 5.7.2.1: Exhausted gas flow of the dedusting machine).

The limit values of **1,000 fibres/m³** and of **10,000/100,000 fibres/m³** are also used in the TRGS 519 to define requirements for the use of technical and organisational safety measures and for personal protective equipment:

TRGS 519: Asbestos, demolition, reconstruction or maintenance work
8. Safety measures
8.2 (2) The asbestos fibre content discharged in the air outside must not exceed 1000 F/m³. [F = fibres]

9. Personal protective equipment
9.2 (7) With respect to work activities with low exposure levels [< 10,000 fibres/m³] according to section 2.8 wearing respiratory protective equipment may be waived in general. [own translation]
9.3 (1) The workers must be given appropriate protective suits that must be worn. […] (2) This does not include work activities, during which a figure below 10,000 F/m³ has been demonstrated, and, if there is no physical contact with asbestos-containing material. [own translation]

14. Special regulations for demolition and reconstruction works on weakly bound asbestos products apply:
14.1 Requirements for extensive work:
(2) The aim of the requirements is to fall below an asbestos fibre concentration of 1,000 fibres/m³ in the white area of airlocks and the area around of the working area.

14.2 Requirements for personall airlocks [own translation]
(3) A three-chamber airlock is sufficient, if
1. the fibre concentration is less than 100,000 fibres/m³,
2. for a fibre concentration of more than 100,000 fibres/m³ when three or less workers are assigned provided the working time does not exceed two shifts.

14.5 Cancellation of protective measures (release)
[…] protective measures may only be discontinued, if the upper limit of the 95% confidence interval calculated assuming a Poisson distribution for the asbestos fibre concentration, is below 1,000 fibres/m³.

17. Special regulations for maintenance work on asbestos products
(1) The following requirements describe certain technical measures to be taken aimed at staying below an asbestos fibre concentration of 10,000 F/m³. [F = fibres]

References

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Risk figures and exposure-risk relationships in activities involving carcinogenic hazardous substances. 2008
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16 The system for inspection and enforcement of the exposure limits

The ban on the placement on the market and the use of asbestos and asbestos containing products with a mass content of more than 0.1% asbestos was implemented 1993 according to the Restriction Ordinance of Chemicals (Chemikalienverbotsverordnung – ChemVerbotsV). In addition, the Hazardous Substance Ordinance (Gefahrstoffverordnung – GefStoffV) is envisaging a ban of manufacture and use of asbestos at the workplace in the future with two exemptions (Annex II, Number 1, (1) Hazardous Substances Ordinance):

- demolition work,
- reconstruction and maintenance work with the exception of work leading to removal of the surface of asbestos products unless low-emission processes are involved, that are recognised by the authorities or by the statutory accident insurance institutions. The processes affected by the prohibition of the removal of surfaces containing asbestos shall include in particular abrasion, pressure cleaning, brushing and drilling.
  (This ban also applies to private consumers.)

Therefore an inspection system has been established to enforce the application of **recognized low-emission processes**. Furthermore, the inspection system enforces, in addition to risk assessment, medical examinations, the instruction of workers, organisational measures (e.g. separation of working areas, reduction of number of workers in the working to the lowest number), supplementary protective measures concerning activities involving exposure to asbestos (Annex I, Number 2, Para. 2.4.1, 2.4.2 GefStoffV). The supplementary technical and personal safety measures include e.g. the dust-tight separation of the working area, room ventilation system, respiratory protective equipment, protective suits and, where necessary, other personal protective equipment (Annex I, Number 2, Para 2.4.3 GefStoffV).
TRGS 519 specifies general requirements for the protection of workers during demolition, reconstruction or maintenance work and waste disposal according to the Hazardous Substances Ordinance especially with regards to supplementary asbestos safety measures. With respect to asbestos a worst case assumption is applied. Thus the application of all protective measures is postulated Exposure levels of less than 100,000 fibres/m^3 shall be enforced by the application of **standardized working practices**. In addition, the duty to notify the local OSH authority of these activities prevails and it has to be ensured that these activities are carried out by specially trained and certified workers with the required expertise acquired in officially recognized courses.
However, in case of **work with low-exposure levels** defined as an asbestos fibre concentration at the workplace below 10,000 fibres/m³ the obligations can be relaxed (No. 2.8 TRGS 519). For showing low-exposure work measurements to provide prove of a low exposure at a specific workplace is not always needed. Under specific conditions measurement results of comparable working procedures can be used (No. 2.9 TRGS 519). The occupational safety and health institute of the Berufsgenossenschaften (institutions for statutory accident insurance and prevention) (IFA) publishes data on working processes (BGI 664 contains the latest additions, www.dguv.de) where asbestos fibre concentrations at the workplace were measured

to be below 10,000 fibres/m³ because of the specified work sequence (No. 2.9 TRGS 519).

Proposed **standardized work procedures** are tested by the working committee Asbestos Exposition at demolition work, reconstruction and maintenance work (“AK Asbestexposition bei Abbruch-, Sanierungs- oder Instandhaltungsarbeiten") at the IFA. Members of this committee are affiliated with the BGen, IFA, Compentent Authorities and further experts. Accepted work procedures are integrated in the publication BGI 664 (“Berufsgenossenschaftliche Information”) and published on the IFA website.
The regulation of demolition and reconstruction works is based on the differentiation between weakly bound (raw density below 1,000 kg/m³) and asbestos cement products (bulk density above 1,400 kg/m³). Work involving weakly bound asbestos products is stronger regulated, because of the considerably higher risk of exposure.
Demolition and reconstruction work on **weakly bound asbestos products** are not covered by the definition of low-exposure works and hence has to be carried out by specialised companies authorized by the competent authority (No. 3.1 TRGS 519). TRGS 519 provides special requirements on the technical and organisational safety measures, and the personal protective measures to be used for these works (No. 14 TRGS 519). The requirements can be relaxed for work of minor extent (14.4). Work of a minor extent is defined as work done by not more than two employees and not exceeding four hours, and a fibre-concentration per working shift of less than 100,000 F/m^3 (2.10). Work of minor extent is typically characterized for example by removal of asbestos cardboard beneath window sills, coating of weakly bound asbestos-containing plates in good condition by rolling.
The regulations on works with **asbestos cement products** foresee special regulation for **demolition** works (No. 16 TRGS 519) in an outdoor environment (16.2) and indoors (16.3), and as well for **maintenance** work on asbestos cement products (17.2), seals and packing (17.3), and braking systems and clutches (17.4). In general, maintenance work must be carried out without causing any destruction, and should prevent release of asbestos fibres to the greatest possible extent. If this is not possible, the asbestos containing parts must be moisturized as far as possible (17.1).

The **Asbestos Directive** (Asbest-Richtlinie) regulates the assessment and subsequent refurbishment of weakly-bounded asbestos products located in buildings according to the § 3 Building regulation (Bauordnung) of the Federal States of Germany. The directive defines specific duties for the developer of demolition and reconstruction works in buildings. The federal Asbestos Directive (§ 3 Asbest-Richtlinie) defines three tiers according to the need to renovate weakly bounded asbestos products to reduce the risk of asbestos exposure. Category (I) defines the immediate need of reconstruction, category (II) the intermediate need, and category (III) the long-term need. In case of an immediate need, that, however, cannot be implemented immediately, an interim solution for organisational, technical or construction measures (e.g. coating of the asbestos product) have to be implemented to prevent fibre exposure in the indoor environment (§ 4.2). Furthermore, the Asbestos Directive defines procedures for final reconstructions (§ 4.3), and specific safety measures during reconstruction according to the TRGS 519.

The competent authorities are legally required to supervise compliance to these specific regulations of work with asbestos containing products. In the case of non-

compliance with the Hazardous Substance Ordinance the **Chemical Act** (§ 26 Para. No. 8b Chemikaliengesetz – ChemG) defines sanctions (§ 26: fines, § 27: criminal offences). In case of violations of specific regulations for working with asbestos products fines can be imposed. Violation against the ban of the placement on the market, manufacture and use of asbestos or asbestos containing products can be punished by imprisonment (up to 2 years) or a financial penalty. Deliberate criminal offences which endanger life and health can be punished with imprisonment up to 5 years.

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The risk-based concept for carcinogenic substances developed by the Committee of Hazardous Substances. Federal Institute for Occupational Safety and Health (BAuA). 2013
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TRGS 519:
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17 Estimated economic losses due to asbestos-related diseases

Between 1990 to 2012 the expenses of the **German Social Accident Insurance** for occupational diseases caused by asbestos exposure (medical expenses, pensions to sufferers and dependents) amounted to **6.1 bn €**. It is estimated that the expenses will rise up to 10 bn. € (BREUER, 2005).

Tab. 17.1 Total expenses attributable to occupational diseases OD No. 4103, 4104, 4105, 4114
(Source: ODs Documentation, DGUV, 24 September 2012, 20 December 2013; calculations conducted by the author(s))

Occupational diseases (OD)	**OD No.**				
	4103	**4104**	**4105**	**4114**	**Sum**
1990 – 2012	**Asbestosis**	**Lung cancer/ larynx cancer, Asbestos**	**Mesothelioma, Asbestos**	**Lung cancer, Asbestos and PAH**	
Total expenses	913,641,433 €	2,591,040,951 €	2,639,135,211 €	3,812,254€	**6,147,629,848 €**
Rounded	0.9 bn. €	2.6 bn. €	2.6 bn. €	0.0038 bn. €	**6.1 bn. €**
Including: Expenses for pensions	769,238.414 €	2,166,859,928 €	2,215,784,634 €	2,546,314 €	5,154,429,290 €
2012	69,183,170 €	206,852,472 €	230,909,589 €	1,520,864 €	508,466,095 €

The following table shows the expenses in 2012 of the German Social Accident Insurance for the different cost categories and the Figure 17.1 the relative shares of these cost categories:

Tab. 17.2 OD costs according to different cost categories
(Source: ODs Documentation, DGUV, 24 September 2012, 20 December 2013; calculations conducted by the author(s))

Occupational diseases (OD)	**OD No.**				
	4103	**4104**	**4105**	**4114**	**Sum**
2012	**Asbestosis**	**Lung cancer/ larynx cancer, Asbestos**	**Mesothelioma, Asbestos**	**Lung cancer, Asbestos and PAH**	
Medical rehabilitation	12,198,961 €	30,409,868 €	38,151,473 €	448,098 €	81,208,400 €
Employment participation benefits	24,968 €	39,602 €	29,206 €	-	93,776 €
Pensions to sufferers	37,456,531 €	48,809,768 €	33,858,119 €	619,354 €	120,743,772 €
Pensions to dependents	19,502,710 €	127,593,234 €	158,870,791 €	453,412 €	306,420,147 €
Sum	**69,183,170 €**	**206,852,472 €**	**230,909,589 €**	**1,520,864 €**	**508,466,095 €**

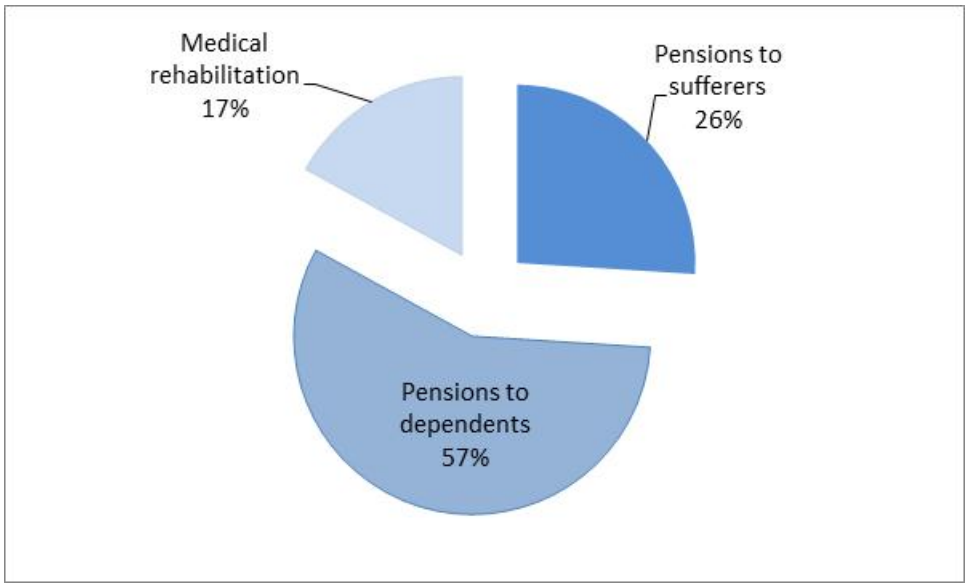

Fig. 17.1 Distribution of OD-costs (OD No. 4103 – 4105, 4414) over cost categories
(Source: DGUV, calculations conducted by the author(s))

Thus the expenses for pensions are **83%** of the total expenses for OD attributable to asbestos caused OD. In **2012** the expenses for pensions amount to **427 M. €**:

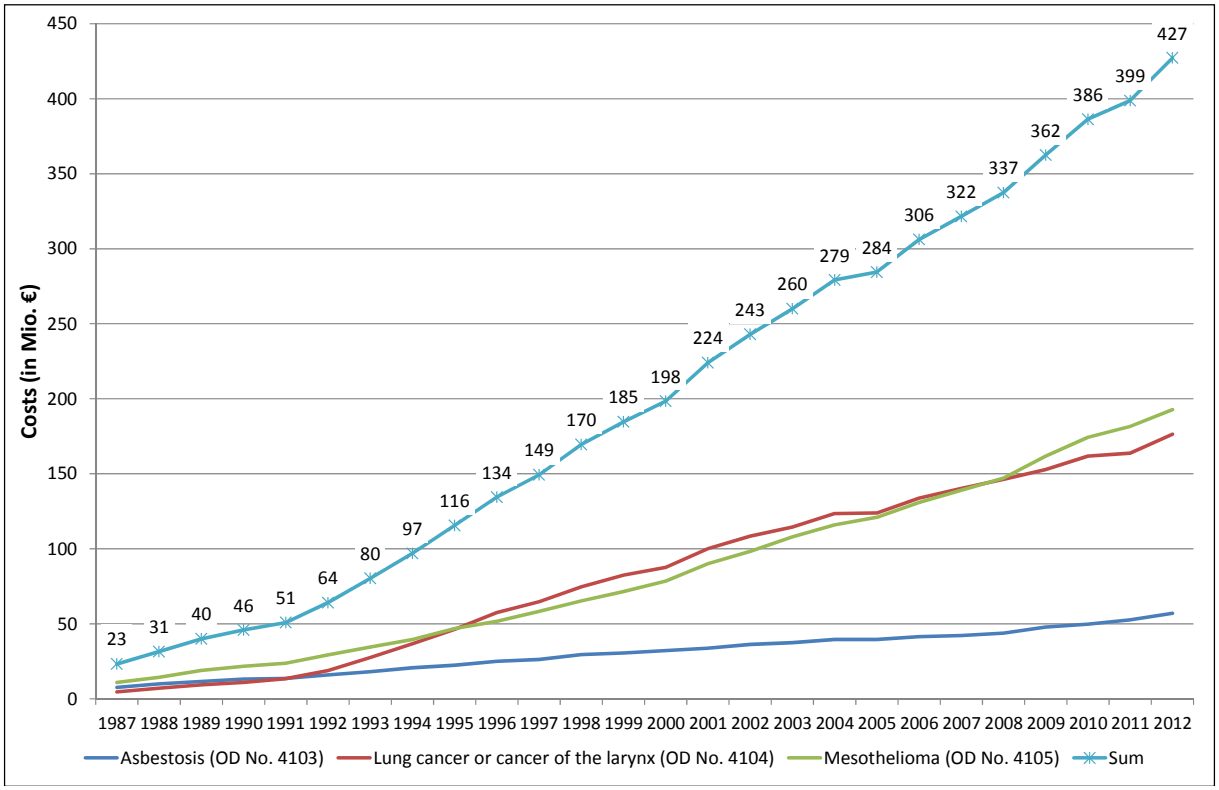

Fig. 17.2 Costs for new pensions per year
(Source: DGUV, calculations conducted by the author(s))
*Because OD Lung cancer caused by asbestos and PAH (OD No. 4114) is recognized just since 2009 it is not shown here.

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Figures

Tables