



BGMG

**Measurement system for exposure
assessment of the German Social Accident
Insurance Institutions**

BGMG

**Measurement system for exposure
assessment of the German Social Accident
Insurance Institutions**

Edited by: BGIA – Institute for Occupational Safety and Health
of the German Social Accident Insurance,
Sankt Augustin, Germany

Published by: Deutsche Gesetzliche Unfallversicherung (DGUV)
Mittelstraße 51, 10117 Berlin
Germany
Phone (+49)30 288763-800
Fax (+49)30 288763-808
Website: www.dguv.de
5th updated edition: September 2009

Typesetting and layout: DGUV, Kommunikation (KOM)

Printed by: Medienhaus Plump, Rheinbreitbach

ISBN: 978-3-88383-804-5
(online: 978-3-88383-805-2)

Content

Goal and scope	5
Cooperation between the accident insurers and the BGIA	8
BGMG quality management (QM) system	10
Measurements and investigations by the measuring services of the accident insurers in accordance with Art. 19, SGB VII	12
Measuring and sampling methods for the investigation of exposure in work areas and analysis	14
Continuous and discontinuous measuring methods	14
Sampling with subsequent analysis in the laboratory (discontinuous methods)	14
Analysis of samples taken at the workplace	15
Direct-reading measuring methods	17
The BGIA's pool of measuring equipment	17
Measuring and sampling methods for biological agents	19
Measuring methods	19
Scope of investigation	20
Round-robin testing	21
Collecting and recording workplace-related, exposure and sampling data in the BGMG	23
BGIA analysis reports	25
Measurement report	27
Documentation of the exposure data in the BGIA's MEGA exposure database	28
Exchange of experience and training within the BGMG	31
BGIA folder Messung von Gefahrstoffen	33
BGMG bulletins	35
BGMG online	36
Collecting and recording workplace-related, exposure and measured data in the OMEGA software on noise	37
Literature	39

Goal and scope

The purpose of the Measurement system for exposure assessment of the German Social Accident Insurance Institutions – BGMG is to measure and document valid and quantifiable measurement data and the associated company data on exposure to hazardous substances and biological agents at the workplace. The integration of noise measurements in the BGMG is in preparation. The BGMG has gone a long way towards achieving the goal of a largely comprehensive assessment of risks at the workplace and reflects the importance of risk identification under the German Occupational Safety and Health Act. The hazardous substance and noise databases within the BGMG make use of the same code indices for types of company (industrial sector), work areas and activities. With the aid of these codes, different work-related factors can be linked, assessed and utilized for the prevention work of the accident insurance institutions (referred to in the following as “accident insurers”).

The BGMG is organized by the BGIA – Institute for Occupational Safety and Health of the German Social Accident Insurance and the measuring services of the statutory accident insurers, with precisely demarcated tasks. The data obtained are available to the accident insurers for prevention work, rehabilitation and epidemiology and for investigations in connection with reported cases of occupational diseases; the BGIA uses these data for evaluations and publications.

The BGMG fulfils the formal and technical requirements of the Hazardous Substance Ordinance (GefStoffV) by basing its work particularly on the requirements to be met by measuring bodies in the performance of measurements of hazardous substances in the air at the workplace in accordance with Art. 9, Section 6, GefStoffV. However, the measuring bodies of the accident insurers do not act on the basis of the Hazardous Substances Ordinance, but in accordance with Art. 19, German Code of Social Law (SGB) VII. A quality management (QM) system ensures that the quality of measurement and validity of the results match those of accredited measuring bodies.

The principles for cooperation between the accident insurers and the BGIA within the BGMG are laid down in a code of procedure. This code of procedure has been adopted by the statutory accident insurers (BGs) of the industrial sector, the public sector accident insurers and the Federal Association of the Statutory Accident Insurance Institutions of the Agricultural Sector (BLB) with its members (Table 1).

The BGMG is the outcome of cooperation initiated in 1972 between the then Dust Research Institute (STF) of the Federation of the Statutory Accident Insurance Institutions of the Industrial Sector (HVBG) and a number of accident insurers on the principle of the decentralized sampling and central analysis of dusts at workplaces.¹

¹ Coenen, W.: Meßtechnisches Überwachungsprogramm der gewerblichen Berufsgenossenschaften zum Schutze vor Stäuben und Gasen am Arbeitsplatz. Staub – Reinhalt. Luft 42 (1982) No. 3, pp. 85–89

Table 1:

Bodies participating in the BGMG (as of July 2009)

BGIA – Institute for Occupational Safety and Health of the German Social Accident Insurance, Sankt Augustin

Statutory accident insurers (BGs) of the industrial sector

- > BG in the mining industry, Bochum
- > BG the quarrying industry, Langenhagen
- > Administrative association of the BG for mechanical engineering and metalworking and the BG for the iron- and steelmaking industry, Düsseldorf
- > BG in the metalworking industry in northern and southern Germany, Mainz
- > BG in the electrical, textile and precision engineering industries, Cologne
- > BG in the chemical industry, Heidelberg
- > BG in the woodworking industry, Munich
- > BG in the papermaking industry, Mainz
- > BG in the printing and paper-processing industry, Wiesbaden
- > BG in the leather industry, Mainz
- > BG in the foodstuffs industry and catering trade, Mannheim
- > BG in the meat-processing industry, Mainz
- > BG in the sugar industry, Mainz
- > BG in the building industry, Berlin
- > BG in the trade and distribution industry, Mannheim
- > BG in the administrative sector, Hamburg
- > BG railway, metropolitan railway and tramway sector, Hamburg
- > BG in the vehicle operating trades, Hamburg
- > Maritime BG, Hamburg
- > BG in the health and welfare services, Hamburg

Public sector accident insurers

- > Local-authority accident insurance association, Hannover/Accident insurer for Lower Saxony, Hannover
- > Accident insurer for Saxony-Anhalt, Zerbst
- > Accident insurer for Hesse, Frankfurt am Main
- > Accident insurer for Thuringia, Gotha
- > Oldenburg local-authority accident insurance association, Oldenburg
- > Accident insurer for Rhineland-Palatinate, Andernach
- > Accident insurer for North-Rhine Westphalia, Düsseldorf
- > Accident insurer for the North, Kiel
- > Accident insurer for Mecklenburg-Western Pomerania, Schwerin
- > Accident insurer for Baden-Württemberg, Stuttgart
- > Accident insurer for the Saarland, Saarbrücken
- > Accident insurer for National Government, Wilhelmshaven
- > Bavarian local-authority accident insurance association, Munich
- > Accident insurer for posts and telecommunications, Tübingen

Federal Association of the Statutory Accident Insurance Institutions of the Agricultural Sector (BLB), Kassel

- > Agricultural BG for Schleswig-Holstein and Hamburg, Kiel
- > Agricultural BG for Lower Saxony and Bremen, Hannover
- > Agricultural BG for North-Rhine Westphalia, Münster
- > Agricultural and forestry BG for Hesse, Rhineland-Palatinate and the Saarland, Darmstadt
- > Agricultural and forestry BG for Franconia and Upper Bavaria, Bayreuth
- > Agricultural and forestry BG for Lower Bavaria/Upper Palatinate and Swabia, Landshut
- Agricultural BG for Baden-Württemberg, Stuttgart
- Agricultural BG for Central and Eastern Germany, Hoppegarten
- Horticultural BG, Kassel

The measuring services of 45 accident insurers with their roughly 290 experts belonged to the system in 2008. Along with the BGIA test laboratories, which carry out about 90% of the analyses associated with the BGMG, five BGMG test laboratories have been set up at the accident insurers. Table 2 shows the number of measurements of hazardous substances and biological agents conducted in 2007.

Table 2:
Measurements in 2007

	Number
Companies	4,373
Samples	34,543
Analyses	137,534
Hazardous substances	567

The trend over time in the number of samples taken at workplaces and analyses of hazardous substances and biological agents at the BGIA is presented in Figure 1.

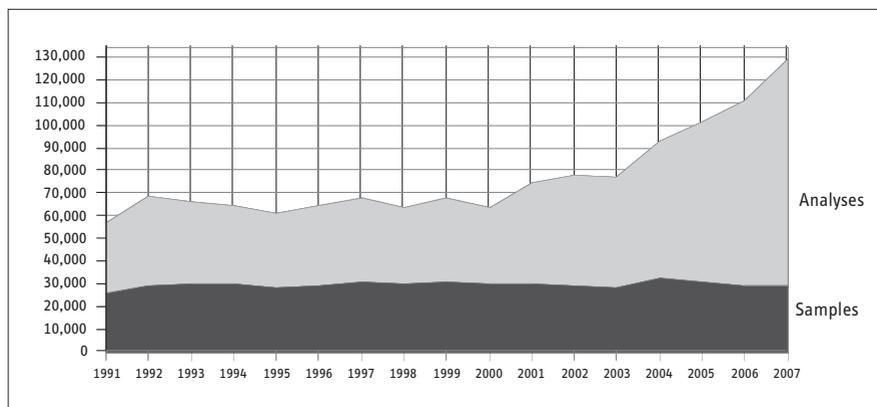
Table 3:
Sample distribution according to size of company

Company size	Percentage of samples
Small companies 1 to 50 employees	35
Medium-size companies 51 to 1,000 employees	59
Large companies > 1,000 employees	6

A breakdown of the samples according to origin (small, medium-size and large companies) in 2007 yields the distribution given in Table 3.

Measurement work is focused on small and medium-size companies.

Figure1:
Trend in samples and analyses within the BGMG



Cooperation between the accident insurers and the BGIA

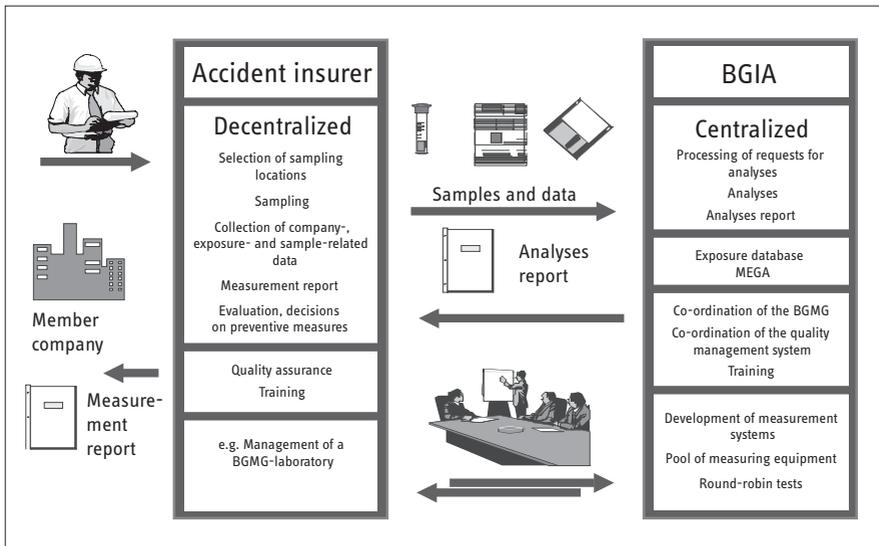
Cooperation within the BGMG is characterized by a fixed allocation of tasks between the measuring services and the BGIA (Figure 2).

The accident insurers

- > contact their member companies on all issues concerning investigations and monitoring and to give advice
- > purchase and manage the measuring equipment
- > select sampling locations and workplaces
- > carry out preliminary investigations into the presence of the substances concerned, into the work procedure and into exposure conditions in the work area

- > collect workplace-related, exposure, sampling and measured data on site
- > take samples of the air and materials; in certain circumstances measurements are performed with direct-reading measuring systems
- > send samples for analysis to the BGIA or to another BGMG laboratory
- > assess the exposure situation on the basis of the BGIA analysis report
- > issue the measurement report for the company
- > store the results for further use
- > are responsible for decentralized quality assurance
- > are responsible for the initial and further training of the staff of the measuring services and test laboratories within the BGMG

Figure 2:
Cooperation between the accident insurers and the BGIA within the BGMG



The BGIA

- > organizes and coordinates the entire measuring and quality management system
 - > is responsible for the development, provision and refinement of measuring and analysis methods
 - > develops software and other working aids for the accident insurers
 - > makes sample carriers available
 - > analyses the samples of hazardous substances and biological agents under the required analytical conditions
 - > records incoming samples and data
- > issues a uniform analysis report with instructions for the measuring services for the assessment of the measurement results
 - > is responsible for the central documentation of the collected data in the exposure database MEGA (German acronym for “measured data on exposure to hazardous substances at the workplace”)
 - > organizes the exchange of experience among all those participating in the BGMG, including training and advising authorized staff

BGMG quality management (QM) system

In 1991, the general managers of the accident insurers and the then HVBG and the management of the BGIA introduced a code of procedure. This code defines organizational matters and cooperation within the BGMG with the goal of ensuring uniform procedures and hence a uniformly high standard of quality.

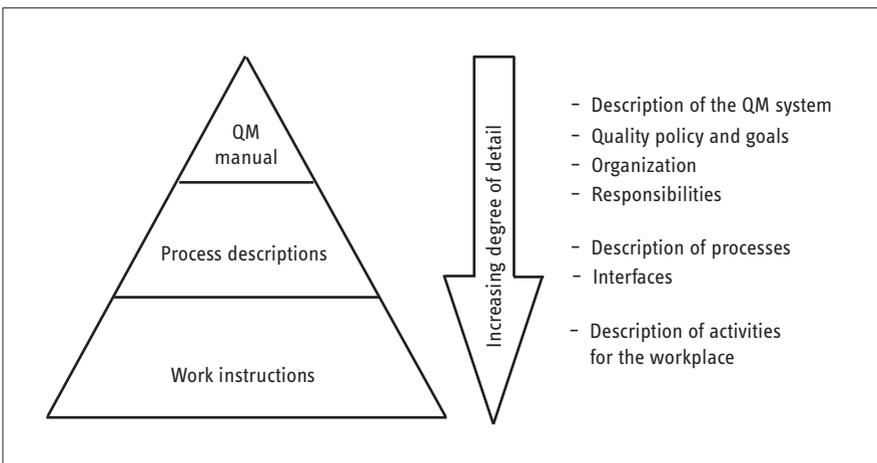
In 1999, a QM system (Figure 3) was introduced in all the participating bodies that essentially lends greater precision to the code of procedure in accordance with the guidelines for management systems under DIN EN ISO 9001:2000 “Quality management systems. Requirements”. The goal is to consolidate and further develop quality-assuring measures and the harmonized and uniform procedure and outwardly

communicate this clearly. This is supported by the management processes for staff training (see section “Exchange of experience”, page 31), the calculation of ratios and regular management assessments and audits.

Within the BGMG, the test laboratories are operated in accordance with DIN EN ISO 17025 “General requirements for the competence of testing and calibration laboratories”.

Of the core processes of the BGMG – from receiving requests for measurement through to the issuing of measurement reports – special mention should be made of the handling of measurements and analyses in accordance with standard

Figure 3:
QM system within the BGMG



work instructions, the further development of data acquisition, and uniform reporting with positive trends. The BGMG makes great efforts in the supervision of test and inspection equipment, measurement programmes and the development of new measuring methods – and with positive results. As laid down in the code of procedure, the BGIA is responsible for coordination of the QM system.

The QM Circle has issued a QM handbook presenting BGMG quality policy. BGMG processes are subdivided into management, core and supporting processes. This is where uniform processing methods are defined. The essential quality-assuring specifications include:

- > Measurements and sampling may only be carried out by appointed persons – the “authorized staff within the BGMG”. Each year, the heads of the measuring services appoint or confirm the appointments of this authorized staff. The authorized employee and all other persons involved undergo thorough training and each year attend further training seminars in which they are instructed in current developments.

- > The heads of the measuring services regularly attend the BGMG exchange of experience at the annual Hazardous Substance Expert Meeting at the BGIA.

- > The quality officers of the accident insurers regularly audit their sections. They attend the exchange of experience of BGMG quality officers which is supervised by the BGIA. A quality circle decides on uniform procedures for audits.

- > On the basis of the audits and management assessments, a Quality Report is issued and documented once per year for the BGMG. This is coordinated by the BGIA at the Hazardous Substance Expert Meeting with the heads of the measuring services and of the test laboratories and is supplied to the prevention managers of the accident insurers.

Available to the participating staff are a large number of work instructions on sampling with special equipment, on measurement programmes, analysis methods for specific substances, data collection and setting technical targets for assessments, measurement reports and the organizational process. As a result of these measures, the standard of quality for the BGMG is comparable to that of accredited measuring bodies.

Measurements and investigations by the measuring services of the accident insurers in accordance with Art. 19, SGB VII

According to Art. 9, SGB VII, the accident insurers have the legal task, among others, of monitoring accident prevention and advising their members. They fulfil this obligation by investigating hazardous substances and biological agents at industrial workplaces in connection with their monitoring duties and advisory work. The measuring services observe this task particularly by taking samples of the air and materials at the workplace and gathering the necessary information. The measurement strategy is defined by the Technical Rule for Hazardous Substances (Technische Regel für Gefahrstoffe, TRGS) 402 "Ermitteln und Beurteilen der Gefährdungen bei Tätigkeiten mit Gefahrstoffen: Inhalative Exposition" (Determining and assessing risks from activities with hazardous substances: Exposure due to inhalation).

Measurements can be performed by the measuring service for a number of different reasons:

- > Workplace assessments prompted by the Technical Supervisory Service with recommendations for protective measures and on the state of the art
- > Identifying exposure sources at machines and installations
- > Conducting series of measurements at comparable workplaces in different companies. This way, process- and substance-specific exposure can be identified and the findings converted into process- and substance-specific

criteria (Verfahrens- und stoffspezifische Kriterien, VSK).

- > Conducting series of measurements at comparable workplaces in different companies as a basis for BG/BGIA recommendations as an aid to risk assessment
- > Measurements before and after modernization, taking account of the changing use of processes and substances
- > Comparative measurements on different exposure reduction installations under the same workplace and process conditions.
- > Measurements in occupational disease proceedings in so far as the exposure data are relevant to the case in question
- > Workplace assessments in occupational disease proceedings if a decision has to be taken on whether health-damaged insured persons may remain at their workplaces under the given exposure conditions or technical reduction measures have to be taken

The results of all these measurements enable the accident prevention insurers to take decisions relating to

- > workplace assessments in connection with their supervisory duties,
- > general substance and process assessments and
- > exposure assessments in occupational disease proceedings.

The measuring services are not responsible for measurements according to Arts. 7 to 11, GefStoffV, since these are in the hands of the in-house or external measuring bodies.

Along with measurements in connection with their supervisory duties, the accident insurers carry out extensive measurement programmes on special hazardous substance or biological agent issues, with the results being published for those interested.

Measuring and sampling methods for the investigation of exposure in work areas and analysis

Continuous and discontinuous measuring methods

Exposure to hazardous substances at work can be determined with two basic methods:

- > Discontinuous methods
Sampling and analysis are temporally and spatially separate. After sampling at the company site, the measuring services send the samples to the BGIA where they are analysed centrally in its laboratories.
- > Continuous, direct-reading methods
This is where the hazardous substance concentration is determined on site with special measuring instruments.

Discontinuous measuring methods are either developed by the BGIA itself or the BGIA modifies methods from other sources and adapts them to the needs of the BGMG. For instance, because of decentralized sampling, it is important to ensure that the samples are not adulterated during transport. Approval of standard measuring methods is preceded by practical testing.

Sampling with subsequent analysis in the laboratory (discontinuous methods)

Usually, the workplace air is drawn by a pump through a sample carrier. The hazardous substance in particulate, vaporous or gaseous form is enriched on or in the sample carrier. The sampling devices

are either installed in a fixed position in the work area or worn by the employee (Figures 4 and 5). For the safe transport of sample carriers and samples and for their storage, special transport systems developed at the BGIA have proven effective (Figure 6).

Figure 4:
Personal sampling device in use during the pouring of diatomaceous earth into a mixing vessel



Figure 5:
Personal sampling systems can take different forms

Personengetragene Probenahmesysteme								
Personengetragenes Gefahrstoff - Probenahmesystem - PGP								
System	GSP	GGP	FAP	FSP	10-l-Zyklon	B 70	Sorptionsröhrchen	Chemisorber
Verwendung	Gesamtstaub	Gase und Dämpfe	Fasern	Feinstaub	Feinstaub		Gase und Dämpfe	
Volumenstrom	3,5 l/min	3,5 l/min	2 - 10 l/min	2 l/min	10 l/min	1,16 l/min	0,33 l/min	0,33 l/min
								
Probenträger/ Sammelphase	Glasfaserfilter	Glasfaserfilter und Kartusche	Membranfilter	Membranfilter	Membranfilter	Absorberflüssigkeit	feste Sammelphase	imprägnierte Filter
								
Beispiele	metallhaltige Stäube	Mineraldampf und-aerosol	Kunstliche Mineralfasern	Quarzeinstaub	Quarzeinstaub DME	Pentachlorophenol	Toluol	Aldehyde

Figure 6:
Transport systems for samples



Analysis of samples taken at the workplace

The measuring services send the samples taken at the workplace to the BGIA, whose central analysis laboratory (Figure 7,

page 16) is capable of efficiently employing elaborate techniques. These are currently:

- > Gas chromatography (GC, Figure 8, page 17)
- > High-performance liquid chromatography (HPLC)
- > Ion chromatography (IC)
- > Atomic absorption spectroscopy (AAS)
- > Atomic fluorescence spectroscopy (AFS)
- > Total X-ray fluorescence spectroscopy (TXRF)
- > ICP mass spectrometry (ICP-MS)
- > ICP atomic emission spectrometry (ICP-AES)
- > UV/VIS spectroscopy
- > Infrared spectroscopy (IR)
- > Potentiometry
- > Capillary electrophoresis (CE)
- > X-ray diffraction (XRD)
- > β -ray absorption
- > Coulometry
- > Mass spectrometry (MS)
- > Light microscopy
- > Electronic image analysis
- > Scanning electron microscopy/energy-dispersive X-ray microanalysis (SEM/EDXA).

In the development and checking of measuring methods, quality assurance is of special importance: Quality assurance takes account of national and international rules and standards (e.g. TRGS 402, DIN EN 482) and demands a high input of working hours and equipment. The procedure and the measuring method requirements to be satisfied by the BGMG are described in detail in the work instructions "Erarbeitung neuer Messverfahren im Rahmen des BGMG" (Development of new measuring methods within the BGMG). In the development of a standard measuring method, the following characteristic data and factors are checked, among others:

- > Working range of the measuring method
- > Precision in the minimum measuring range (0.1 to 2 times the limit value)
- > Detection and quantification limits
- > Recovery rate
- > Effect of atmospheric humidity and temperature
- > Storage characteristics of the sample carriers

Figure 7:
Analysis laboratory at the BGIA



Figure 8:

Thermodesorption gas chromatograph with an MS detector for the analysis of volatile organic compounds (VOCs)



- > Faults caused by foreign substances and the specificity of determination
- > Sample carrier blank readings

Measuring methods are published in the BGIA folder Messung von Gefahrstoffen (measurement of hazardous substances) (see page 33) as measuring methods recommended in accordance with TRGS 402. Methods for important substances are also concurrently developed by other working groups, which also publish measuring methods in collections of methods (German Research Association (DFG), Chemistry Expert Committee).

Direct-reading measuring methods

The result of a measurement is obtained during or immediately after measurement at the workplace. Direct-reading measuring instruments (Figure 9, page 18) are employed particularly for continuous

monitoring – in some cases with an alarm – in areas where, for instance, gaseous or vaporous substances of high acute toxicity are important factors. The use of direct-reading measuring devices is also justified for the determination of mean exposure values and peak exposures if no suitable discontinuous measuring and sampling method is available for the substance in question and in special cases in order to determine process-related peak exposures.

The BGIA's pool of measuring equipment

A special service associated with the BGMG is the BGIA's pool of measuring equipment. An extensive stock of measuring and sampling devices for hazardous substances and biological agents is available for use by the accident insurers. It supplements the BGIA's standard measuring methods and standard measuring equipment of the accident insurers.

Figure 9:

Ozone measurement at a welding workplace with a direct-reading measuring instrument

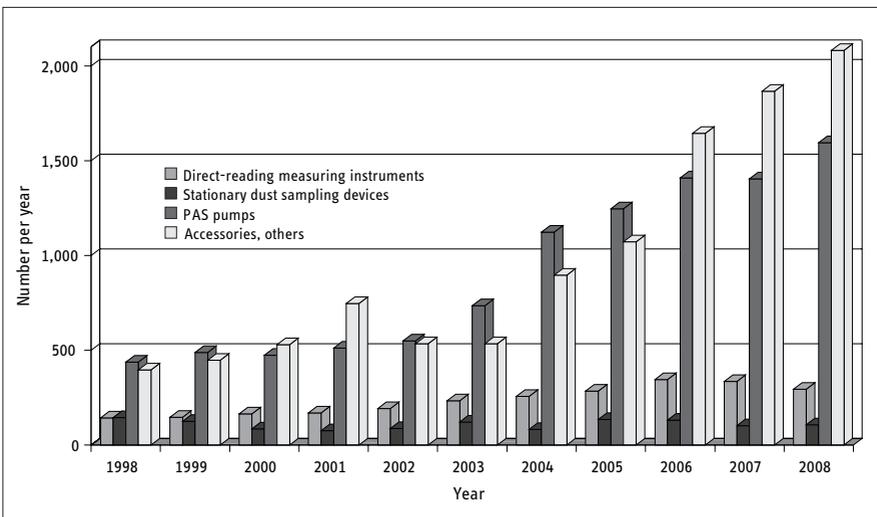


Available are direct-reading gas, vapour and dust measuring instruments as well as stationary and personal sampling devices. The growing frequency of use (Figure 10) shows the high level of acceptance enjoyed by this pool of measuring equipment. In special cases, e.g. to address special measurement issues, measurement

strategy issues or basic investigations, the accident insurers can also entrust the measurement of hazardous substances or biological agents at the workplace to the BGIA. This particularly includes measurements of ultrafine particles for which no measuring method is currently available for general use.

Figure 10:

Measuring equipment pool - trend in equipment use from 1990 to 2008



Measuring and sampling methods for biological agents

In addition to chemical and physical effects, employees may be exposed in various work areas to biological agents such as bacteria, mould fungi or viruses. Microorganisms can cause not only infections among exposed employees, but also allergic/toxic diseases of the respiratory organs, particularly if bioaerosol concentrations are continuously high. An example is exogenous allergic alveolitis (EAA, e.g. farmer's lung and humidifier fever among others).

Measuring methods

The BGIA plays a leading role in the development of suitable assessment parameters, the standardization of measuring methods and development of measurement strategies. The written procedures for this are issued in close cooperation with the Committee for Biological Agents (Ausschuss für Biologische Arbeitsstoffe, ABAS) and published in the BGIA folder (see page 33).

Biological agents (Figure 11) are sampled by authorized staff of the measuring services or, in special cases, employees of the

Figure 11:
Sampling of biological agents (in this case mould spores) during building modernization



BGIA on site at the company. The samples are then taken to the institute's laboratory and investigated there for the respective biological agents concerned.

Scope of investigation

The BGIA investigates samples of air and materials for mould spores, bacteria, yeasts, endotoxins and actinomycetes. Several measuring methods have been standardized for sampling and adapted to the particular work area.

The investigation of the mix of species in air and material samples is carried out in some cases by the BGIA and in others by partner laboratories. Above and beyond the standardized methods, the BGIA conducts analysis, e.g. into legionella or mite allergens.

The institute equips authorized staff with sample carriers and devices for the measurement of biological agents and gives detailed advice on everything to do with sampling.

All investigation findings are brought together at the BGIA, communicated to the accident insurers in an analysis report and stored in the MEGA exposure database. By December 2007, the database contained roughly 57,000 data sets on about 390 biological agents.

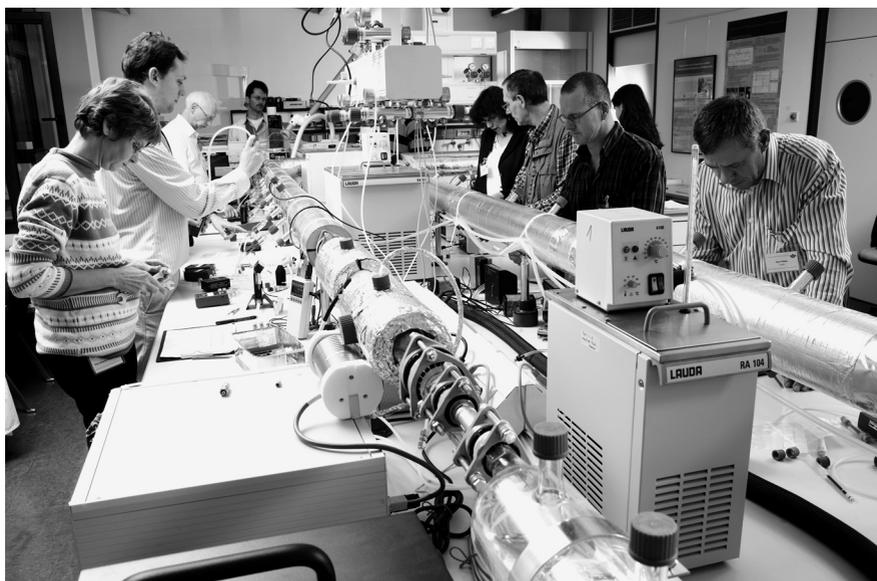
Topical information on the sampling of biological agents can be found in the intranet of the accident insurers (UV-Net) under Webcode 8736.

Round-robin testing

Round-robin tests are one of the main ways of documenting the quality of a laboratory with external quality assurance activities. All the laboratories involved in the BGMG participate in round-robin tests with the analysis methods at their disposal (Figure 12). The BGIA takes part in round-robin testing on, for instance, asbestos, chromates, inorganic acids, metals on membrane filters, aldehydes, solvents, chlorinated hydrocarbons, ketones, nitrosamines and moulds.

Since 1989, the BGIA has been additionally offering all laboratories and measuring bodies for hazardous substances round-robin tests for internal monitoring and as a means of outwardly demonstrating the internal quality of the laboratory. Since 2005, there has been a dynamic test gas facility at the BGIA for the simulation of atmospheres with volatile hazardous substances under conditions applicable to workplaces. During round-robin tests at the test gas facility, up to 12 participants can take samples simultaneously. Round-robin testing is carried out in accordance with the specifications of ISO Guide 43 and made available worldwide. The BGIA is currently organizing the following round-robin tests:

Figure 12:
Sampling at a test gas facility during a round-robin test for the measurement of volatile compounds



Without sampling:

- > Metals from metal dusts
- > Solvents on activated carbon (B type or NIOSH type)
- > Volatile inorganic acids on silica gel
- > Low-volatility inorganic acids on quartz fibre filters
- > Polycyclic aromatic hydrocarbons (PAHs) on Teflon filters and XAD 2 tubes
- > Volatile organic compounds (VOCs) on Tenax with thermodesorption

With sampling:

- > Solvents (several times per year)
- > Volatile inorganic acids
- > VOCs
- > Direct-reading measuring devices

Collecting and recording workplace-related, exposure and sampling data in the BGMG

Alongside sampling, a large number of data are gathered in companies so that the sample can later be analysed in its proper context, the results assigned to the workplace, and the ambient workplace conditions can be ascertained to permit an assessment and interpretation of the measurement results. Together, the accident insurers and the BGIA develop uniform instructions on how these data are to be gathered. The measuring service currently gathers for each sample up to 200 and more items of data which are collected with the aid of the OMEGA hazardous substances software. OMEGA is the computer-aided organization system for the collection and use of measured data on exposure to hazards at the workplace. The OMEGA system links the code indices, specialized files and record files together and ensures data workflow from the measuring services via reporting at the BGIA through to documentation of the data in the MEGA exposure database without data having to be manually gathered a second time.

The following data are collected:

- > Company with sector of industry
- > Work areas
- > Activities
- > Production processes, equipment
- > Working materials, input products
- > Spatial, climatic and ventilation conditions
- > Protective measures
- > Exposure conditions

- > Sampling conditions
- > Measuring methods
- > Measured values
(e.g. from direct-reading devices)
- > Supplementary surveys at welding and cooling lubricant work places and for indoor air measurements

These data contain all the information required for a proper recording of the workplace-related, exposure and sampling conditions for measurement. Also recorded is the information on the exposure conditions required for the analysis report. Efforts are made to identify and describe all the factors that can affect the measurement result. In addition, the work area is indexed with the categories of type of company, work method and activity (job description) of the insured person. This ensures that data from comparable work areas can be brought together in anonymized form and statistically processed.

The authorized staff collect the data in the company with the aid of the OMEGA hazardous substances software (Figure 13, page 24). The data sent to the BGIA with the hazardous substance sample are stored there in a database.

The OMEGA hazardous substances software is an integral aspect of quality assurance for the BGMG. Both during data input on site and in the central OMEGA software at the BGIA and in the software versions in operation in other BGMG test laboratories,

Figure 13:

Example of an input mask of the OMEGA hazardous substances software, data sampling

The screenshot shows a software window titled "Betriebs- und Expositionsdaten - [Angaben zur Probenahme]". The window has a menu bar with "Ende", "Bearbeiten", and "Menü". Below the menu bar is a toolbar with various icons. The main area is a form with the following fields and controls:

- Messserie:** 2007 testfirebird
- Probe:** 1
- IBA:**
- Navigation tabs: air sample | analysis | material
- date of sampling:** . .
- reason of measurement:** [dropdown menu]
- kind of sampling:** [dropdown menu]
- measurement system:** [input field] [search icon]
- registration number of sampling system:** [input field] [search icon]
- sampling type:** [input field] [search icon]
- individual sampling type number:** [input field]
- time of sampling:** . .
- duration sampling:** [input field] h min
- volume flow:** [input field] l / min m³ / h
- remarks:** [input field] [submit icon]

At the bottom of the window, there are two buttons: "copy" and "trash".

the data are subjected to plausibility tests and checks of completeness. The user is guided and aided with extensive help

functions such as overview lists, copying functions, the definition of favourites and opportunities for data transfer.

BGIA analysis reports

For each measurement of hazardous substances or biological agents, the BGIA issues an analysis report. This is based on the data gathered on the work area, exposure and the analysis findings.

The BGIA analysis report comprises:

- > Cover sheet with details of the accident insurer and the insured company
- > Overview table of measured values
 - Substance and assessment indices and CMR classifications according to TRGS 905 and/or Directive 67/548/EEC
 - Mean values (arithmetic mean, median) for biological agents
- > Description of work areas with details on
 - Activities
 - Production processes and working material/products
 - Sampling location, ventilation, climatic conditions
 - General conditions relating to exposure and sampling
 - Measurement results from single samples

> Appendices:

Details of workplace limit values and classifications of hazardous substances plus remarks on the analysed hazardous substances and biological agents; overview of measuring methods for the analysed hazardous substances and biological agents; explanation of the calculation of the indices and legend for symbols and abbreviations

This analysis report (Figure 14, page 26) is prepared in such a way that it can help the supervisory services of the accident insurers to a large extent in the assessment of the exposure conditions at the workplace. It is structured so that the accident insurers can issue the harmonized BGMG measurement report from it.

The measuring services of the accident insurers receive from the BGIA a print-out of the BGIA analysis reports as well as Microsoft® Word files of the analysis report and a prepared measurement report.

Figure 14:

Extract from a BGIA analysis report on the overview of measured values

Sample No.	Hazardous substance	Date Duration of sampling Time of sampling	Duration of exposure Time of exposure	p/s	Occupational Exposure Limit	Measurement value	Time factor for reference to shift	Index
1	n-Hexane	05.06.2007 2 h 10:00-12:00	3 h/shift	p	180 mg/m ³ AGW	90 mg/m ³ (n = 1)	2.67	0.19
1	Toluene	05.06.2007 2 h 10:00-12:00	3 h/shift	p	190 mg/m ³ AGW	45 mg/m ³ (n = 1)	2.67	0.09
2	4-Hydroxy- 4-methyl- pentan-2-one	05.06.2007 2 h 10:00-12:00	3 h/shift	p	96 mg/m ³ AGW	75 mg/m ³ (n = 1)	2.67	0.29
1 - 2	Index of evaluation							0.57
Identified CMR-substances: n-Hexane (R ₃) Toluene (R ₃)								
Description of work area sector (branch) repair shop for motor vehicles work area painting, surface coating, manual brushing occupation automotive restorer number of exposed workers in work area during measurement 1, total 1 Production plant (working equipment/processing procedure) <i>Brush (manual brushing)</i> processing discontinuous manual number of shifts 1 Working material (products) <i>Working Material</i> Coating name of product Coating XYZ processing amount 1.2 kg/shift name of producer Coating Ltd. City relevant ingredients Toluene n-Hexane 4-Hydroxy-4-methyl-pentan-2-one Technical information measuring point room, closed length/width/height: 10 m/7 m/3.5 m effect of other emission sources no Ventilation system natural ventilation no natural ventilation (windows/doors closed) technical ventilation waste air prevalent above area of detection with input air air velocity ceiling input air, bottom waste air								

Measurement report

The measurement report of the accident insurers satisfies the requirements of the instructions of the German Laender (regions)². For the most part, the bodies concerned adopt the given structure, thus ensuring a uniform pattern.

The final exposure assessment, taking account of the general workplace and production conditions, is undertaken by the employee who conducted the measurement on site. On the basis of the measurement report, the accident insurer can take the measures that it deems appropriate.

The BGIA supplies software for the production of the harmonized measurement report. The structure of this report is already prepared in the analysis report; texts can be added at any point. With the aid of macro-programming, a cover sheet with the identification of the measurement report and the naming of the persons involved in measurement is produced, the assessment relating to the work area is called up and a table of contents is created.

² Instruction „Grundsätzliche Anforderungen an akkreditierte Messstellen zum Vollzug des Gefahrstoffrechts“, LASI publication LV 2.2, update of 2005-08-01

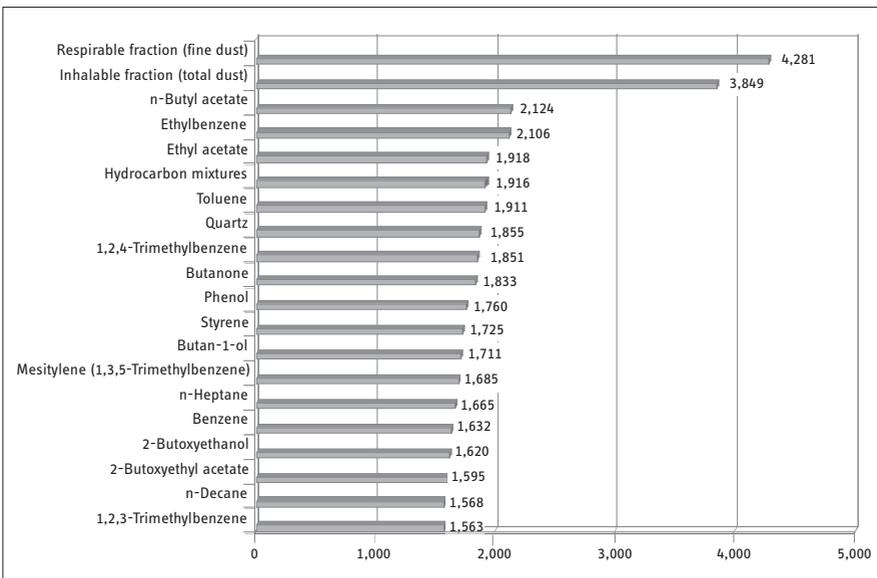
Documentation of the exposure data in the BGIA's MEGA exposure database

All the data collected in the BGMG are brought together and documented in the BGIA's exposure database MEGA. The database has been in existence for hazardous substances since 1972. Archived data have been subsequently entered, which means that for some work areas measured values going back to 1962 are available. Data on biological agents have also been documented since 1998. Table 4 shows the total scope achieved by the end of 2007, and the most frequently analysed individual substances are listed in Figure 15.

Table 4:
Scope of the MEGA exposure database

	Number
Data records	1,933,000
Hazardous substances	793
Biological agents	393
Companies	53,000

Figure 15:
Overview of the twenty most frequently analysed hazardous substances in the BGMG (2007)



The basic framework for documentation is the code indices for industrial sectors, work areas, activities and substances as well as other parameters affecting the measured value, which were developed jointly with the accident insurers. These data are available for special cross-sectoral evaluations, e.g. on substances, work areas, technical details and other factors. These include, among other things, retrospective analyses for investigation into reported substance-induced occupational diseases and to establish substance-specific exposure levels with the current state of the art in certain work areas and sectors of industry.

Evaluations in the context of prevention contribute, among other things, towards BG/BGIA recommendations and are available to companies as an aid to risk assessment. Equally, trend analyses are also issued for exposure levels for specific substances and processes.

Work area registers with retrospective overviews of exposure are published in BG/BGIA reports such as Report 8/2006e "Quartz exposure at the workplace". For the evaluated data periods and selected data universes, this report presents the respective 90th percentiles of the cumulative frequency distributions for about 100,000 measured values.

To present the statistical results, reference can be made not only to the cumulative frequency distribution, but also to the box plot diagrams used in the following two examples. The box comprises the middle 50% of the measured values from the 25th to the 75th percentile. The median is shown as a black line in the box. The whiskers extend from the biggest to the smallest measured value, which is a maximum of 1.5 times the box length from the top or bottom of the box. Values outside

the whisker are classified as extreme values. These are marked with circle or star symbols. Values marked with a star are over 3 times the box length from the top or bottom of the box.

As the result of a MEGA evaluation, Figure 16 (see page 30) shows the trend analysis of quartz dust concentration and of the concentration of the respirable dust fraction during metalworking in machine and vehicle manufacture. Figure 17 (see page 30) highlights the variation in the concentrations of the respirable dust fraction and quartz in different working areas during the extraction and preparation of gravel and sand in the period from 1995 to 2004.

The principles for evaluation have been laid down by the accident insurers and the German Social Accident Insurance in an administrative agreement that also takes account of data protection. As a result, it is not possible to trace the identity of the company or the accident insurer. An overview of anonymized cross-sectoral evaluations by the BGIA is available to the accident insurers by means of a search program (http://bgia-online.hvbg.de/VE_MEGA/WebForm1.aspx) in the UV-Net, webcode 10985.

Anonymized evaluation results may only be passed on to third parties with the consent of the accident insurers whose data have been included.

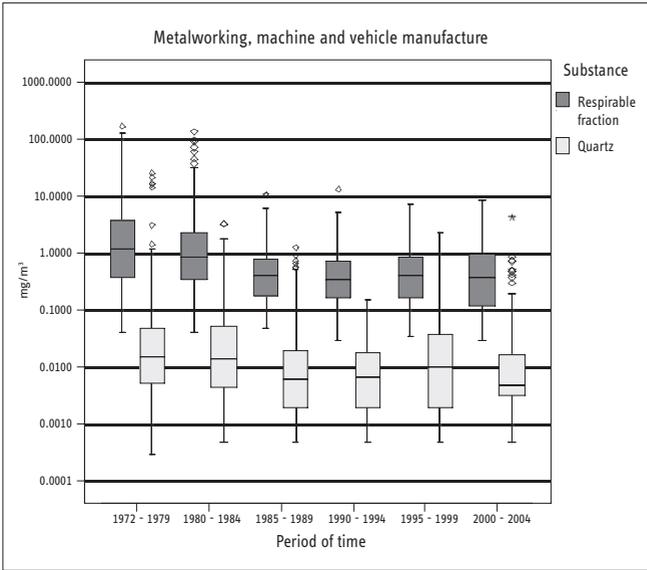


Figure 16: Trend in average shift values for the concentration of the respirable dust fraction and the quartz concentration during metalworking in machine and vehicle manufacture

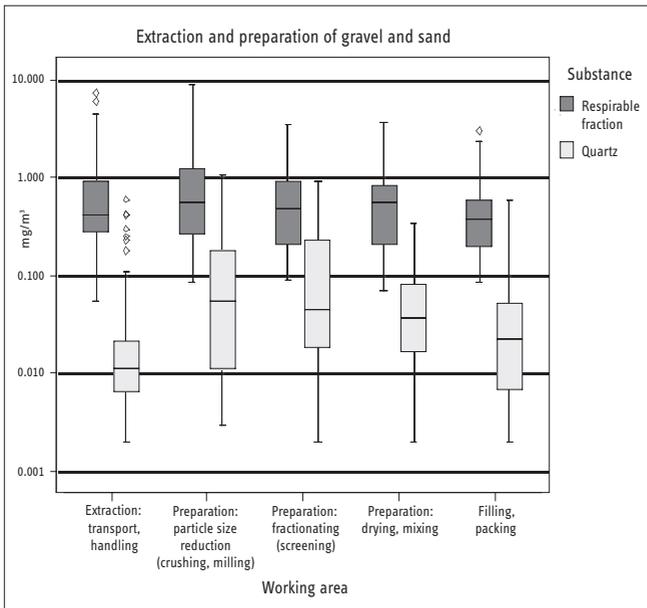


Figure 17: Mean shift values for the concentration of the respirable dust fraction and for the quartz concentration in different working areas during the extraction and preparation of gravel and sand, during the period from 1995 to 2004

Exchange of experience and training within the BGMG

Both the accident insurers and the BGIA are responsible for the initial and further training of the staff involved in the BGMG. In consultation with the accident insurers, the BGIA provides an array of different courses, seminars, exchanges of experi-

ence and expert meetings (Table 5). In some cases the events target very different groups and are often organized and also in some cases held in cooperation with experts in the respective fields.

Table 5:
Seminars and events within the BGMG

Title	Abbreviation
Hazardous substances expert meeting	FGG
Measurement and assessment of hazardous substances	G1
Measurement and assessment of hazardous substances - Exchange of experience for authorized staff of the BGMG	G2
Reducing exposure to hazardous substances - Technical protective measures during activities with hazardous substances (seminar on current issues)	G3
OMEGA hazardous substances software training	G5
Risk assessment: Determining the level of exposure due to inhalation	G6
Measurement techniques: Hazardous substance measurement with direct-reading measuring devices	G7
MEGA training	G8
Testing and inspection equipment maintenance and calibration	G9
Hazardous substance measurements at the BGIA test gas facility	G10
Risks from biological agents at the workplace - Introductory seminar with practice exercises	B1
Risks from biological agents at the workplace - Exchange of experience	B2

Once per year, a meeting is held on the subject of hazardous substances and biological agents and is attended by the heads of the measuring services and the test laboratories. For employees new to the measuring services, the BGIA provides a suitably designed introductory seminar (G1). The “Hazardous substances” seminar (G2) is held as a means of deepening existing knowledge, reporting on experience and finding out about current developments. The seminar “Reducing exposure to hazardous substances – Technical protective measures during activities with hazardous substances” (G3) addresses current issues. This is where individual substances are discussed from the point of view of occupational safety and health along with substance-independent issues such as technical protective measures.

How to use the OMEGA hazardous substances software for the recording of workplace-related and sampling data is covered by a special training session (G5). In the seminar “Risk assessment: Determining the level of exposure due to inhalation” (G6) participants are familiarized with equipment-free methods of determining the level of exposure due to inhalation as an addition or alternative to equipment-based measurement of exposure at the workplace.

The seminar “Measurement techniques: Hazardous substance measurement with direct-reading measuring devices” (G7) deals with the principles of selected direct-reading systems, data evaluation, the integration of measurement results in the analysis and measurement reports, and quality assurance issues. Another emphasis is on practical exercises with devices from the BGIA’s pool of measuring equipment.

Subject to demand, the range of seminars also includes training (G8) for the selection of the data sets of a particular accident insurer for the calculation of statistical parameters of defined data universes and for the thematic/technical interpretation of the evaluation results.

The uniform procedure for the maintenance and calibration of testing and inspection equipment in the measuring services is covered by seminar G9. This event supplies information on flow rate adjustment and the functional testing of sampling systems, their calibration and the documentation of testing and inspection equipment in the QM system. New is the seminar G10 on the dynamic BGIA test gas facility which is primarily concerned with the quality assurance of sampling.

Along similar lines as the introduction to the “Measurement of hazardous substances” (G1) and the more detailed hazardous substances seminar (G2), there are events on biological agents (B1 and B2). The first part of this seminar covers basic information on biological agents and how to measure them, while the second goes into greater depth and includes an exchange of experience.

BGIA folder

Messung von Gefahrstoffen

The BGIA folder on the measurement of hazardous substances brings together, among other things, experience and findings from the BGMG (Figure 18). The folder thus serves as a basis for the everyday work of authorized staff as well as

being a valuable reference work for other experts interested in measuring equipment, in the documentation of measured data and in the assessment of hazardous substance exposure.

Figure 18: BGIA folder Messung von Gefahrstoffen, available from Erich Schmidt Verlag, Berlin, as a loose-leaf collection or on the Internet at www.bgia-arbeitsmappedigital.de



It deals with the following topics:

- > Principles of the measurement of hazardous substances and biological agents
- > Assessment of exposure
- > Information on technical guidance documents
- > Work area monitoring, requirements to be met by measuring bodies, quality assurance
- > BGI A sampling devices and methods
- > Data acquisition and analysis reports
- > Documentation of measured data and workplace-related data
- > Measuring methods for hazardous substances and biological agents

The worksheets – available online at www.bgia-arbeitsmappdigital.de or as a loose-leaf collection – are regularly brought into line with developments in technical guidance documents and extended to include new and modified measuring methods.

BGMG bulletins

The BGMG information service reports to all participants on the latest important changes and developments in technical

guidance documents, sampling, analysis, the assessment of results, organization, etc. (Figure 19).

Figure 19:
Overview on the BGMG-Infos 2008

The screenshot shows a web browser window displaying the BGMG website. The main content area features a table titled "BGMG-Infos 2008" with two columns: "BGMG-Info" and "Inhalt". The table lists various bulletins from 2008, including dates and brief descriptions of their content.

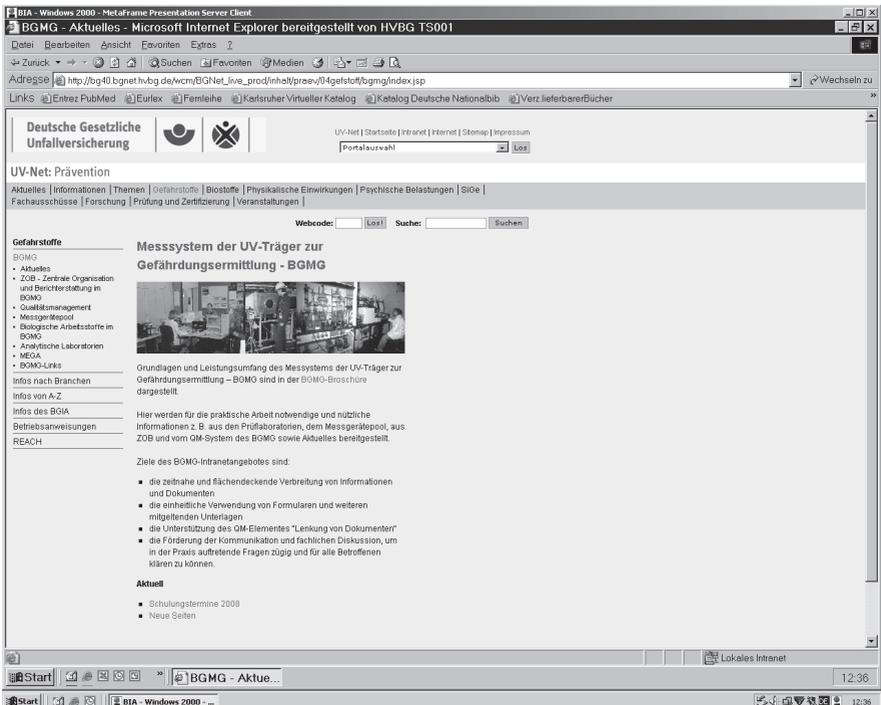
BGMG-Info	Inhalt
19/2008	Messung von Aldehyden und TVOC in Innenräumen - Schulungen
18/2008	QM-Flyer zur Weitergabe an Dritte
17/2008	Messung biologischer Arbeitsstoffe: 17.1 Neue Struktur der B-Seminare 17.2 Anleitung zur Probenahme biologischer Arbeitsstoffe
16/2008	Neuer Probenträger für die Bestimmung von Chromaten
15/2008	15.1 Termine für den Einsendeschluss von Proben zum Jahresende 2008 15.2 Seminarangebot 2009 für die am BGMG Beteiligten
14/2008	Messen des Gefahrstoffes „Bis(2-dimethylaminoethyl)ether“
13/2008	13.1 Kombierter BGA-Analysenbericht für Gefahrstoffmessungen und Messungen biologischer Arbeitsstoffe im BGMG 13.2 Aktualisierung der Handlungsanleitung zum BGMG-Messprogramm 9143: „Mikrobielle Besiedlung wassergemischter Kühlschmierstoffe“
12/2008	Engpass bei der Analyse von Chlor, Wasserstoffperoxid und Quecksilber
11/2008	BGMG-Berichterstattung für Gefahrstoffe: - Geänderte Ausgabe der Bewertungsindizes und der KMR-Stoffe - Überarbeitete Anhänge zum Analysenbericht - Darstellung der Ergebnisse bei Materialproben
10/2008	Fachgespräch "Neue TRGS 402"
9/2008	ISCO-HV 2007 - Neues BGMG-Schlüsselverzeichnis für Tätigkeiten/Berufsbezeichnungen
8/2008	Volumenstrom für die Langzeitprobenahme von Lagerschichten (AK 26)

BGMG online

The BGIA operates an online platform for all participants (Figure 20). For practical work, it provides useful information from the test labs, on the pool of measuring equipment, from BGIA-ZOB (central organization and reporting department), on the exposure database MEGA, on the QM system and on other topical subjects. The goal is to achieve a comprehensive quality-assured transfer of data on all areas of the BGMG.

The available BGMG information can be found on the UV-Net (Webcode 5125) and is retrieved in institution-specific form. The BGIA draws attention to new content via its email service.

Figure 20:
Homepage of BGMG online



Collecting and recording workplace-related, exposure and measured data in the OMEGA software on noise

Noise measurements to determine noise exposure levels at the workplace are in many cases a first important step towards implementing the Ordinance on the Protection of Employees from Noise- and Vibration-related Hazards (LärmVibrations ArbSchV). The results of these measurements serve as the basis for risk analysis and the specification of noise areas as well as for the assessment of cases of noise-induced hearing loss and for the choice of suitable hearing protection devices. On the basis of the results, decisions can be taken on the need for protective measures of a technical or occupational medical nature. Measurements to determine the noise exposure level call not only for an understanding of acoustic principles and measurement equipment, but also sound knowledge of the parameters that need to be measured.

The goal is the uniform collection, assessment and documentation of noise measurements at workplaces in companies. With the OMEGA software on noise, all the key workplace-related and measured data are covered and it is possible to assess a workplace on the basis of

- > the noise exposure level $L_{EX,8h}$ ($L_{EX,40h}$)
- > the C-weighted peak sound pressure level L_{pCpeak}

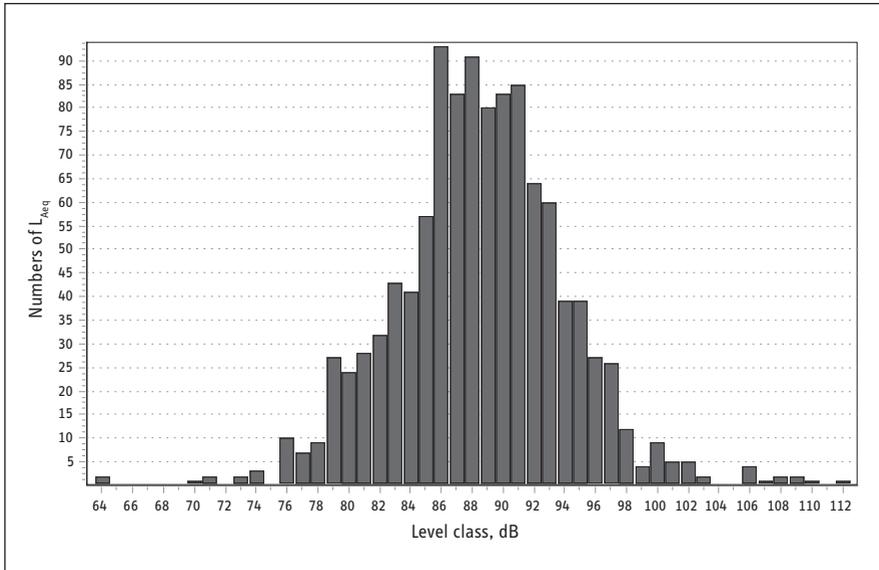
Along similar lines as the OMEGA software for hazardous substances

- > uniform targets are developed jointly by the accident insurers and the BGIA for the data being collected
- > the sector of industry, work area and activity and indexed with the same categories
- > certain obligatory details are recorded for reasons of quality assurance and to permit data comparability
- > measurement reports are issued that contain all the necessary information for proper recording
- > the data in the MELA noise exposure database are brought together at the BGIA for statistical purposes and evaluated with specially developed software in the event of inquiries, e.g. on cases of occupational diseases (Figure 21).

The following are core aspects of the collection and evaluation software:

- > Company
- > Measuring devices
- > Type of company (sector of industry)
- > Work area
- > Sampling location
- > Activity
- > Main noise source
- > Machine
- > Measured values
- > Frequency analyses
- > Spatial conditions
- > Noise reduction measures

Figure 21:
 Example of a noise level frequency distribution on the MAG welding data
 from the MELA documentation



The OMEGA software on noise makes use of the same codes for industrial sectors (company types), work areas and activi-

ties as the OMEGA software for hazardous substances. Cross-hazard evaluations are thus possible.

Literature

BGIA-Arbeitsmappe Messung von Gefahrstoffen. Ed.: BGIA – Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung, Sankt Augustin. Erich Schmidt, Berlin – loose-leaf ed. www.bgia-arbeitsmappedigital.de

BGMG hazardous substances measurement system. No. 0021, ed. 6/2006. In: Focus on BGIA's work. Ed.: BGIA – Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung, Sankt Augustin – loose-leaf ed. www.dguv.de, Webcode e24884

Gabriel, S.: BGMG: Über 100 000 Analysen von Gefahrstoffen und biologischen Stoffen von Arbeitsplätzen im Jahr 2004 im BGIA. Gefahrstoffe – Reinhalt. Luft 65 (2005) No. 5, p. 209-211. www.dguv.de/bgia, Webcode d4527

Gabriel, S.: The BG Measurement System for Hazardous Substances (BGMG) and the Exposure Database of Hazardous Substances (MEGA). Int. J. Occup. Saf. Ergon. 12 (2006) No. 1, p. 101-104

BGIA-Expositionsdatenbank MEGA. No. 0207, ed. 8/2009. In: Aus der Arbeit des BGIA. Ed.: BGIA – Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung, Sankt Augustin – loose-leaf ed. www.dguv.de, Webcode d3849

Gabriel, S.; Voitl, S.; Charissé, M.; Deppe, D.: Das Qualitätsmanagementsystem im Berufsgenossenschaftlichen Messsystem Gefahrstoffe – BGMG. Gefahrstoffe – Reinhalt. Luft 66 (2006) No. 1/2, p. 33-37. www.dguv.de/bgia, Webcode d4559

**Deutsche Gesetzliche
Unfallversicherung e. V. (DGUV)**

Mittelstraße 51

10117 Berlin, Germany

Phone (+49)30 288763-800

Fax (+49)30 288763-808

Website: www.dguv.de