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BG MEASUREMENT SYSTEM: HAZARDOUS SUBSTANCES AND THE EXPOSURE DATABASE MEGA

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ABSTRACT

The Berufsgenossenschaften, carriers of statutory accident insurance in industry in Germany (BGs), have been collecting data on exposure to hazardous substances and physical hazards at workplaces for many years. The results of these measurements form the basis of individual exposure assessments and, based on these assessments, companies are encouraged whenever necessary to take measures to reduce exposure. With the help of systematic surveys on special working methods, the effectiveness of organisational or technical measures is tested in order to find general process and substance-specific solutions to be able to comply reliably with limit values.

Since 1972, all measurement results have been documented in the MEGA database at the BIA. This database is used as the basis for prevention work, indicating areas requiring monitoring and allowing the activities of the BGs' Measuring Services to be managed.

A number of examples will illustrate how exposure data in the BGs' measurement system "Hazardous Substances" is collected and used.

THE MEASUREMENTS AND INVESTIGATIONS OF THE BGs' TECHNICAL INSPECTORATES

The BGs are legally required to use all appropriate means to prevent accidents and occupational diseases. Among other things, this involves supervising accident prevention and advising members. The BGs fulfil this legal obligation by carrying out investigations at in-plant workplaces as part of their monitoring and advisory duty. This task is performed by the Technical Inspectorates which measure workplace exposure to hazardous substances, physical hazards and ergonomic stress, and collect the necessary information.

Such measurements as part of preventive work are carried out for a wide variety of reasons, for example:

- workplace assessments with recommendations for protective measures
- identification of the sources of exposure to harmful substances in machines and plants
- implementation of measurement series at comparable workplaces in different factories to identify process and substance-related exposures in order to be able to make general statements
- measurements as part of occupational disease evaluation, insofar as the exposure data is of relevance to the specific case.

By fulfilling these tasks, the Technical Inspectorates enable the BGs to make effective decisions in terms of prevention on

- individual workplace assessments
- general assessments of substances and processes.

The Technical Inspectorates of the BGs are not responsible for fulfilling the legal duty of companies to carry out assessments or, if necessary, measurements; these have to be performed by in-plant or external measuring services.

THE MEASURING SYSTEM “HARMFUL SUBSTANCES” OF THE GERMAN BERUFGENOSSENSCHAFTEN - (BGMG)

The following means of detecting health risks posed by hazardous substances:

- exposure measurement
- exposure assessment
- exposure database
- exposure register

have been combined to create a preventive instrument known as the “Measurement System ‘Harmful Substances’ of the German Berufsgenossenschaften, or BGMG for short [1, 2.]

The purpose of the BGs’ Measurement System “Harmful Substances” (BGMG) is to determine and document valid and conclusive exposure data as well as corresponding company and workplace-related data on harmful substances at the workplace. This system is supported by the joint efforts of both the *Berufsgenossenschaftliches Institut für Arbeitssicherheit* - BIA (BG-Institute for Occupational Safety) and the *Technische Aufsichtsdiene der Berufsgenossenschaften* - TAD (Technical Inspectorates of the Berufsgenossenschaften).

The data collected by the BGMG is made available to the BGs for the purposes of prevention, rehabilitation, epidemiology as well as investigations into reported substance-related occupational diseases, and is also used by the BIA for appropriate evaluations.

COOPERATION BETWEEN THE BGS AND THE BIA

The cooperation in the BGMG is characterised by the well-ordered division of responsibilities between the Measuring Services of the participating BGs and the BIA (Fig. 1). The BGs, which are organised according to branches of industry, are responsible for all tasks requiring direct contact with member companies:

- establishing contact to member companies on all questions related to determination, monitoring and consultancy
- the collection of air and substance samples, if necessary, supplementary direct measurements
- the assessment of the exposure situation, and
- preparation of a measurement report for the company with recommendations for, or if necessary, the ordering of measures.

The BIA, on the other hand, is responsible for the central subject-related and coordinating tasks for the operation of the system:

- the organisation and coordination of the entire measurement system including quality control
- the development and provision of sampling technology as well as supplementary recording measuring equipment and the provision of forms and working aids
- the analysis of samples of harmful substances and compliance with the necessary analytical conditions
- preparation of a uniform analysis report with information about the assessment of measurement results for the BG
- the further development of measurement and analysis methods
- the centralised documentation of collected and determined data in the BIA documentation
Measurement data on workplace exposure to hazardous substances - DOK-MEGA
- organisation of the exchange of know-how among all participants in the BGMG and the training and support of measuring technicians in the BGMG.

In 1995, the Measuring Services of 41 accident insurance carriers with approximately 300 experts participated in the system. In that year, they measured hazardous substances on the following scale:

Number of companies:	4223
Number of samples:	28241
Number of analyses:	61383
Number of hazardous substances:	325

The origin of the samples is also interesting in terms of the size of the enterprise. Approximately 60% of all samples, for example, came from medium-sized companies, i.e. companies with 51 to 1000 employees. Around 25% came from small enterprises and around 15% from large companies. This means that over 80% of all samples come from small and medium-sized companies. The equal distribution of measuring activities in terms of the different company sizes is illustrated if we relate the number of samples to every 1000 employee. This parameter is between 0.6 and 1.6 samples for every 1000 employee in all company sizes.

MEASUREMENT REPORT AND PREVENTIVE MEASURES

On the basis of the BIA's analysis report, the responsible BG can prepare the final assessment, draw up the measurement report and initiate appropriate measures, taking into account conditions that are specific to workplace and production facilities.

In addition to routine measurements in companies, the BGs also carry out specific campaigns. In the past few years, these have included measurements of cooling lubricants (nitrosamines, microbes), measurements during welding work using high-alloy wrought iron on chromate and nickel, measurements of exposure to solvents during parquet laying, etc.

The following procedure is typical here:

1st phase: measurements without special protective measures

- 2nd phase: measures to reduce exposure (protective measures of a technical or organisational nature)
- 3rd phase: measurements with optimised measures
- 4th phase: process-specific recommendations to guarantee low exposure levels - also without measurements.

EXAMPLE: NICKEL

In the first half of the eighties, these kinds of measurements were carried out in a wide variety of working areas. This was prompted by the introduction of a limit value for nickel shortly before. The selected working environments where measurements were carried out ranged from areas where materials are stored, processed and welded to where they are put into containers. The result showed that limiting values were exceeded significantly in certain working areas. Particularly when the material was subjected to thermal stress during processing - as is the case in certain mechanical processing techniques and during welding - considerable deviations occurred. These deviations were sometimes four times the permitted value.

It soon became apparent that these survey measurements alone were not sufficient to be able to take preventive measures effectively and purposefully. Detailed surveys of working areas therefore followed in the second half of the eighties with the aim of determining really critical working processes.

The working areas “Welding” and “Processing” determined by the survey measurements were examined in greater detail. This showed that, with one exception (TIG welding), limit values were exceeded in all welding methods where nickel was used. These upper deviations were particularly serious in the case of certain shielded arc welding techniques and manual arc welding. During the processing of materials containing nickel, polishing and thermal cutting proved to be the most critical working areas. In the mid-eighties, new preventive measures were developed and existing measures improved. Companies were urged by the BGs to take the available preventive measures to reduce risks caused by exposure to nickel at the workplace.

EXPOSURE DATABASE MEGA

All operational and exposure data is recorded in the exposure database MEGA [3]. This database has contained data since 1972 and today comprises a total of around 700,000 data records on 300 different hazardous substances from some 28,000 companies. This database represents a unique instrument for preventive work. For example, with the help of the database

- the main areas of exposure can be determined
- a workplace register can be drawn up
- the effectiveness of preventive measures can be assessed.

The exposure database, however, is also used for other purposes not related to prevention, e.g. for trend analyses and to support investigations into occupational diseases.

The development of sample and analysis volumes in terms of time in the BGMG for the years 1983 to 1995 shows that the number of samples increased by 90% and the number of analyses by 100% in this period. The significant increase since 1990 is undoubtedly partly due to German unification. The BGs quickly established Measuring Services which serve companies in former East Germany.

It is interesting to look at analysis volumes in terms of the different substance groups and their development within the last few years: in the area of respirable and total dust, as well as inorganic dusts, the sample volume remained the same apart from a few minor deviations. The slight decrease in the case of mineral dusts contrasts with a rapid increase in the case of organic substances (Fig. 2).

The “hit list” of the 12 most frequently analysed hazardous substances in 1995 is shown in Fig. 3.

These 12 substances were the most frequently analysed of altogether 272 different substances. In 1995, all 12 substances listed here were determined at least 1,500 times. The analysis of respirable dust in over 5,000 cases is most frequent because these analyses are often the first stage of an assessment, especially when little information is available on the specific substances. Quartz is also a front runner with 3,500 analyses a year, followed by toluene and xylene, in other words, typical solvents.

USING DOK-MEGA FOR PREVENTIVE WORK

Within the framework of the measuring and monitoring activities of the BGs’ Measuring Services within the BGMG, the measuring points are not normally selected as random samples but are chosen in terms of subject-related aspects with specific questions on individual cases, e.g. at workplaces which are suspected beforehand of being critical in terms of the exposure situation, or to examine the effectiveness of reorganisation measures. By producing statistical summaries of the measurement results of comparable workplaces, valuable statements can be made for all kinds of purposes, taking into consideration these premises and with a sound knowledge of conditions that are specific to the industry.

This is why for many years, DOK-MEGA has been used intensively by the BGs for prevention work, epidemiological questions, and also in connection with the retrospective determination of exposure when occupational diseases are reported as being substance-related:

- almost two thirds of all assessments lead to publications focusing on: retrospective determination of exposure and prevention
- another focal point are the evaluations initiated by the BGs in connection with reported occupational diseases
- in working area registers, measurement data is systematically summarised according to sectors of industry, workplaces, activities and time of exposure. These assessments are usually carried out as part of research projects by the BGs.
- appropriate assessments are carried out on “TRK substances” (technical guidance concentrations applied in Germany) where technical developments play a key role in defining limit values. During discussions on limit values, the results are presented to the relevant committees by the BGs.

A series of publications based on data from DOK-MEGA and prepared jointly in the last few years by the BGs and the BIA focuses primarily on prevention. In these publications, exposure data is presented according to the specific sector of industry, workplace and activity to be able to define priority areas where preventive measures should concentrate, and also to determine areas where adherence to limit values can be guaranteed continually. On this basis, the available monitoring staff of the BGs and companies can be employed in a more targeted manner.

Assessments that take into consideration technical measures to reduce exposure provide information for the targeted selection and the appropriate use, for example, of suction and ventilation, and provide information on the effectiveness of these measures.

Trend analyses carried out over a period of years illustrate whether and to what extent measures to reduce exposure have generally taken effect, and where deficits exist.

SOME IMPORTANT EXAMPLES

Fibres

The BIA manual contains a “Working environment dossier on man-made mineral fibres” which presents fibre dust concentrations according to processes and separately for 3 periods between 1981 and 1992 [4].

Exposure data for the 1973 to 1991 period specifically on Respirable dust and quartz in cleaning rooms in foundries - taking into consideration the different suction measures - is contained in the BIA Manual article “Protective measures in cleaning rooms in foundries” [5].

The BIA report 3/91 “Cooling lubricants - handling, measurement, assessment”, contains exposure data on nitrosamines and recommends measures [6].

Organic substances/gases/vapours

In the “Working environment dossier on benzene”, the current exposure situation is presented according to workplace. In addition to data from MEGA-DOK, measurement results from industry were also incorporated in the study. A summary is featured in the BIA Manual article “Benzene at workplaces” [7].

Measurement results and recommendations on Dioxins in waste incineration and metal recycling plants are contained in the BIA Manual article “Halogenated dibenzodioxins and furans at the workplace” [8].

Carcinogenic substances

The subject of carcinogenic substances is treated in publications from 1986 and 1995. 15 or 16 substances are differentiated and presented according to industry for the periods 1981-1984 and 1989-1992 [9, 10, 11].

For the 1989 to 1992 period, the measurement data was evaluated for the 16 carcinogenic substances for which over 50 measurement results were available for the period in question. Altogether 14,898 results from 3576 companies were included in the assessment although only the mean value per shift was considered.

In the case of ten hazardous substances, a comparison with the exposure situation from 1981 to 1984 is possible. This comparison shows that the exposure level for all hazardous substances - in terms of the 90% values - decreased significantly (Table 1).

Table 1: Exposure of Carcinogenic Substances - A Comparison

Agent	1981 - 1984			1989 - 1992		
	limit value (1985) (mg/m3)	% > limit value	90 % value (mg/m3)	limit value (1994) (mg/m3)	% > limit value	90 % value (mg/m3)
Acrylonitrile	7.0	9.5	3.435	7.0	0.0	0.16
Arsenic and its compounds (except arsine)	0.2	0.0	0.020	0.1	2.3	0.007
Benzo(a)pyrene	-	-	0.0029	0.002	5.9	0.0008
Benzene	16.0	1.4	3.08	3.2	5.0	2.0
Beryllium and its compounds	0.002	19.0	0.0031	0.00	10.9	0.0032
Chromates (reported as CrO3)	0.1	8.0	0.0644	0.1	3.6	0.04
Cobalt and its compounds	0.1	16.8	0.167	0.1	10.7	0.012
Nickel and its compounds (except Nickel tetracarbonyl)	0.05	4.4	0.196	0.05	4.3	0.18
Nitrosamines	-	-	0.0054*	0.001	10.4	0.002
Vinylchloride	5.0	3.0	1.0	5.0	0.0	0.1

*Coenen [9] evaluated only one type of nitrosamines. The data reported were derived by taking account of all types of nitrosamines for which results were available for the period 1981/1984.

In addition to assessments and presentations relating to the individual substance, it is useful for practical occupational health and safety measures to assess and present exposure to all relevant and measured substances in terms of working area. This indicates the often very varied exposure pattern of workplaces and allows appropriate conclusions to be drawn for monitoring and targeted measures, as well as possible “releases”.

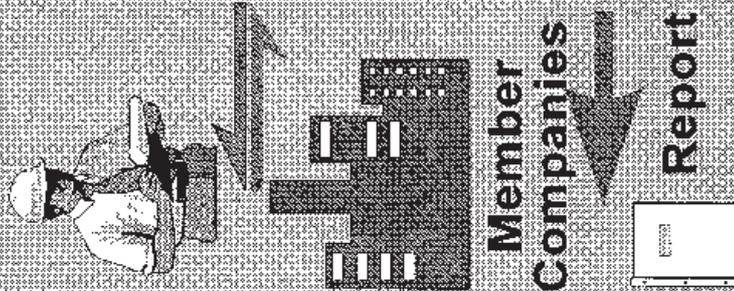
COOPERATIONS AND FURTHER DEVELOPMENTS

With its database MEGA-DOK, the BIA participates in a working group of European exposure databases which examines the comparability of measurement data, for example, in terms of the use of exposure data for European limit values [12].

The BGMG is currently being extended to include measurements of physical and ergonomic stress. This will help achieve comprehensive assessments and develop an appropriate exposure database for prevention.

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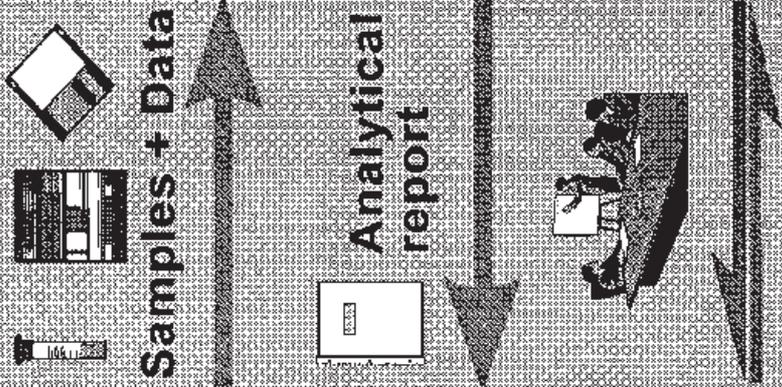
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BG

Decentral.

- Workplace selection
- Sampling
- Comp. related data
- Assessment
- Report
- Decision on prev. measures

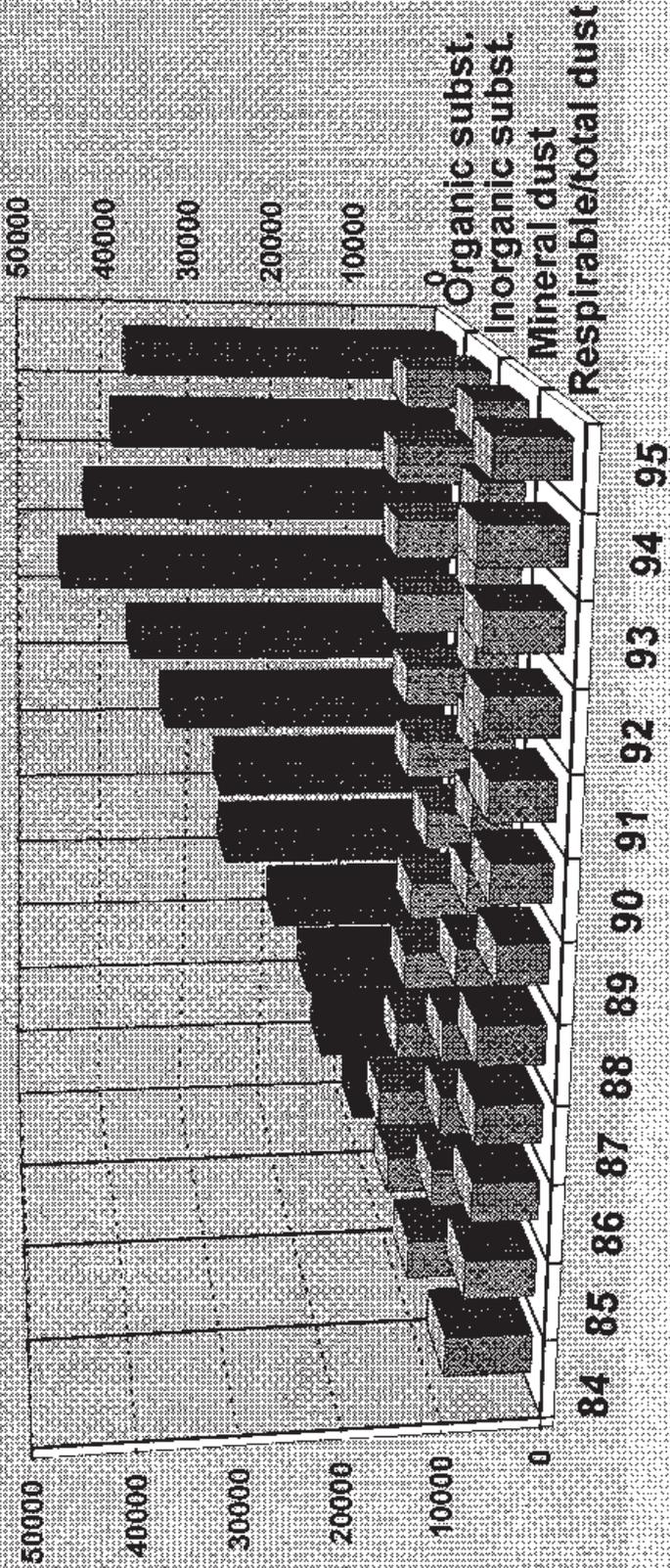


BIA

- Centralized**
- Collection of data + samples
- Analyses
- Analyt. report
- Documentation
- Coordination
- Quality assuran.
- Training

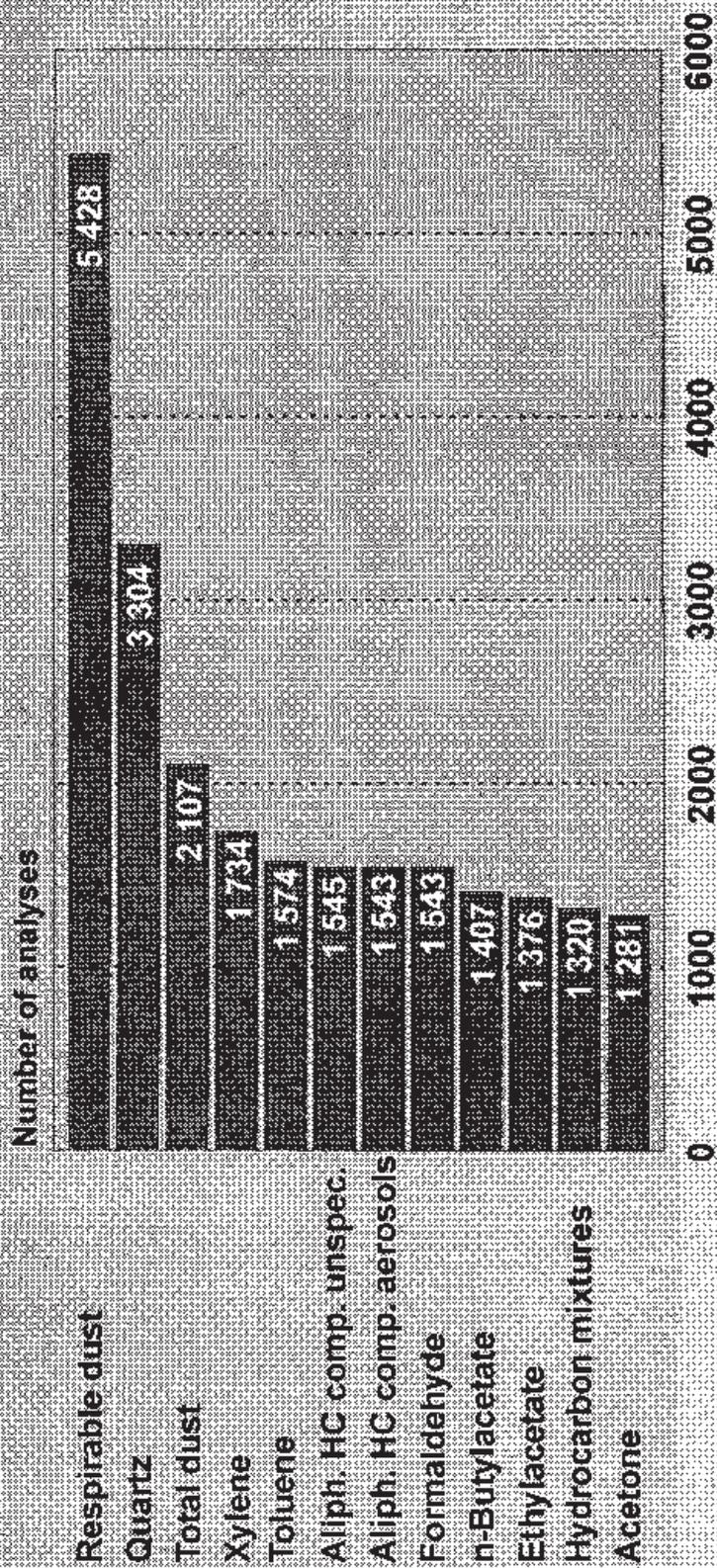


Analyses of hazardous substances



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12 most frequently analysed substances in 1995



925 1004 041