

Research on health and safety at work



Research and Development Programme 2014–2017

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I Role of research and development at the BAuA

The Federal Institute for Occupational Safety and Health (BAuA) is a departmental research institution under the responsibility of the Federal Ministry of Labour and Social Affairs (BMAS). The BAuA evaluates scientific and practical developments within its field of responsibility and addresses the impacts of working conditions on the health and safety of employees in companies and administrative departments. It advises its target groups on all matters relating to health and safety and humane work design. In doing so, the Federal Institute operates at the interface between science and policy and acts as a mediator between the scientific community and politics, workplace practice and society.

The BAuA's range of responsibilities includes research and development activities, scientific policy advice, statutory tasks, transfer tasks, and training and transfer of knowledge via the DASA occupational-safety exhibition. In this context, research and development activities bear particular strategic importance, since these, on the one hand, form the basis for the BAuA's scientific services through application-oriented processing of the available knowledge which will lead to the reduction of knowledge gaps detected in the process and, at the same time, pave the way for knowledge advancement in the field, which is vital from a strategic point of view. Research and development (R&D) therefore lay the foundations for competent, future-oriented fulfilment of the BAuA's range of responsibilities. Due to the fundamental importance of R&D and the special role of long-term perspective in knowledge advancement, the corresponding goals, focal areas and activities are described in this BAuA Research and Development Programme 2014–2017. The

Working Programme 2014–2017 provides a detailed overview of the BAuA's entire range of responsibilities.

The differentiation drawn between research and development in the previous R&D Programme 2010–2013 is retained as an essential structuring characteristic. This time the differentiation is drawn specifically in relation to particular fields of activity in order to better clarify relations to content – including connections with the other fields of responsibility in the BAuA Working Programme.

Research is understood to be the open-ended but nonetheless methodical and systematic search for new knowledge with the aim to design working conditions that are safe, healthy and humane. The frame of reference is provided by the scientific community in the disciplines necessary for the research questions; their interdisciplinary cooperation is indispensable for most problems. Development, on the other hand, is aimed at practice-oriented solutions for defined objectives in the field of preventive action. Development takes the current state of research and transfers it into concrete solutions to address requirements for action and organisation arising from policy, from national and international rules and regulations, including standardisation, and from workplace practice. Transdisciplinary project designs allow experience and practical knowledge to be integrated into development projects in order to ensure the applicability and acceptance of solutions for occupational safety and health, and to ensure high scientific standards.

The R&D activities of the R&D Programme 2014–2017 specify the following strategic fields of activity for the BAuA Working Programme 2014–2017:

1. **Ensuring safe use of chemicals and products.**
2. **Adapting working conditions to the needs of humans.**
3. **Avoiding work-related diseases – promoting health and workability.**
4. **Understanding the impact of a changing working world and further developing occupational safety and health instruments.**

The scope and objectives of the following R&D activities at the BAuA are always shown in the context of technical priority for occupational safety and health using the identifiable need for knowledge and action, as well as the BAuA's long-term strategic research and developmental lines and its associated scientific skills and resources. They relate to the aims and tasks that are a priority for the BAuA and that can be realised in the medium term within the programme period. The BAuA will also strategically employ its diverse technical cooperation relationships and networks, as well as its knowledge management, to systematically observe and analyse research and development topics not actively addressed in its own range of responsibilities and to integrate the results into its own consulting and implementation activities.

II

Research and development focuses

1 Ensuring safe use of chemicals and products

Based on its statutory tasks, the BAuA makes significant contributions through its research and development to the exclusion of products and substances from the market in the event of unacceptable risks and / or to the safe use of such products and substances by way of hazardous-substance and product information and suitable protective measures. Through this, the BAuA is active in the fields of safety and health of employees, as well as in consumer and environmental protection.

1.1 Chemical safety

A uniform and directly applicable legal framework has been established in the EU for chemical safety in recent years with the EU Regulations on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), the Classification, Labelling and Packaging of Substances and Mixtures (CLP) and the placing on the market and use of biocidal products. Within the framework of its statutory tasks, the BAuA assumes the roles of the German Federal Office for Chemicals and of the assessment and enforcement body for occupational safety and health. Research and development provide the scientific basis for carrying out the statutory tasks to a high standard. The activities begin where limits are reached for legally required responsibility for chemical safety on the part of manufacturers and importers of chemical substances, and where state-initiated and state-supported knowledge generation is necessary in order to achieve a high level of safety for humans and the environment.

One essential focus is the search for solutions to knowledge gaps and procedural uncertainties that have already been identified in the legislation, which was only recently introduced. During the programme period, these efforts will centre on improving the communication of risk and measures in the supply chain of chemical substances and the further development of testing and information requirements for nanomaterials and other advanced materials. Furthermore, the institute evaluates and carries out further improvements of instruments used by manufacturers, importers and law-enforcement authorities to fulfil statutory duties. Within the programme period, this will relate in particular to methods for estimating the exposure level for employees in activities involving chemical substances and socio-economic analysis models for substances of very high concern for humans or the environment (SVHCs).

1.1.1 Simplification of the communication of risk and measures in the chemicals supply chain

For the legally prescribed registration process under REACH, manufacturers and importers are required to provide a description of exposure scenarios for safe use of the chemical substances over the entire life cycle in the chemical safety report and in the extended safety data sheet. It now appears that the exposure scenario descriptions are often insufficiently accurate and practice-oriented to allow users to design safe activities in line with statutory occupational-safety requirements. In particular small and medium-sized enterprises in the supply chain find it very difficult to filter out the relevant information from the extended safety data sheets, which comprise up to 1,000 pages.

With control banding approaches, the intention is to develop concepts that simplify the communication of risk and measures in the supply chain for chemical substances and, in terms of a “supplied risk assessment”, make these directly applicable with regard to the statutory occupational-safety requirements.

Research and development with regard to the safety of nanomaterials is to be continued and expanded to cover other advanced materials with the aim of making scientific contributions to the further development of testing and information requirements under REACH and providing advice to start-up businesses.

Control banding includes qualitative instruments or instruments classified according to magnitude (semiquantitative instruments) for risk assessment and management in the workplace. Control banding methods, such as the Easy to Use Workplace Control Scheme for Hazardous Substances (EMKG), have been used successfully in risk management for many years. Within the programme period, literature reviews and expert surveys will be used to investigate which elements of these approaches are also suitable for simplifying risk communication in the supply chain for chemical substances, what added value they provide for the businesses concerned and for the protection of employees, and how they can be integrated into the communication structures under REACH. Practical testing of applications is to be conducted in field investigations, if possible at a European level in cooperation with the European Chemicals Agency (ECHA) and the European Agency for Safety and Health at Work (EU-OSHA).

1.1.2 Nanomaterials and advanced materials

Results from previous safety research show that some nanomaterials release respirable particles and fibres in the workplace that can lead to health risks. Dust-generation behaviour, morphology and biopersistence have proved to be relevant criteria for the assessment of possible risks in the life cycle of nanomaterials, but are not yet taken into account sufficiently in the testing and information requirements for European chemical safety. Furthermore, a possible risk to employees through the inhalation of critical particles is not restricted to nanomaterials, as chemical substances that do not fall under the EU definition of nanomaterials can lead to comparable hazards. This also relates to the advanced materials that were supported for the first time in the European Framework Programme for Research “Horizon 2020”.

For granular microscale and nanoscale particles, methods are being developed to determine biopersistence, and research is being carried out on the long-term effects in the lungs and other organs. On the development side, the shaker method for determining dust-generation behaviour is to be made applicable for regulatory purposes, and the analysis of electron-microscope images is to be accelerated using computer-aided image recognition. Another area of development is the mobile screening of released particles for cytotoxic properties, which is intended in the future to indicate the necessity of further toxicological tests during the development of new materials and substances. Practical aids are being developed on the basis of field studies, particularly in the field of occupational safety and health in research institutions and start-up companies. It is planned to continue to integrate these activities into third-party funded projects with German and international partners. Launched in 2008, the joint research strategy of the German higher federal authority for the safety of nanomaterials for man and the environment will be continued.

1.1.3 Determination of exposure to chemical substances in the workplace

Under the REACH and Biocides Regulations, manufacturers and importers must prove the exposure to substances in the workplace lie below the toxicological effect thresholds. Since measurements are not possible in many cases, estimates are usually made for this purpose using computational models. The competent authorities must also make exposure estimates for their statutory tasks, e.g. within the framework of substance evaluation. Established models and procedural instructions are available for assessing inhalative exposure in standard scenarios, but there are shortfalls with regard to the as-

assessment of specific applications, e.g. the use of spray lances for pest control in populated areas. On the other hand, the evaluation of dermal exposures, especially those relevant to the application of biocidal products, has so far seen little standardisation with regard to methodology and is associated with considerable uncertainties.

The necessary risk assessment of exposures to chemical substances in the workplace is to be refined for the statutory tasks and its methodology developed further, with a focus on “Skin contact” and “Special exposure situations”.

Through literature reviews and field studies, as well as through model investigations in test rooms, clarification is to be sought as to the degree of comparability of dermal-exposure measurements determined by various methods and as to which measurement methods are suitable for regulatory issues with regard to certain activities or substances. In this field of activity, the BAuA cooperates with other German higher federal authorities, international research institutions and other stakeholders in the field of chemical safety.

1.1.4 Approaches to socio-economic analysis for substances of very high concern

The instrument for socio-economic analysis (SEA) introduced with the REACH Regulation – and now also taken up by the Biocides Regulation – assists in the impact assessment of regulatory measures for chemical substances of very high concern (SVHC). The SEA balances the economic benefit against the risks posed by the substances to human health and the environment. In doing so, it also considers substitution with lower-risk substances or procedures. The first concrete applications of the recently introduced SEA in the field of chemical safety highlight a multitude of methodological issues that are to be taken up in research and development projects.

By improving the socio-economic analysis methods, transparency is to be achieved with regard to the benefit of regulatory processes aimed at substituting substances of very high concern, and the quality of the decision-making processes is to be improved.

Literature reviews will investigate and analyse data sources that can be used to determine quantitative indicators for the frequency and severity of disease and for representative medical expenses for the EU. Suitable indicators are to be derived and compiled to form an assessment system in order to allow the estimation of far-reaching economic and social effects of authorisations and restrictions, e.g. on competitiveness. Building on the SUBSPORT project, which is funded by the EU and the BAuA, investigations are to be carried out by way of literature searches, company surveys and the preparation of case studies on how the substitution of high-risk substances, as sought by the REACH Regulation, can be promoted in companies. These R&D activities, especially in relation to the BAuA’s statutory tasks with regard to chemical safety, are to be integrated into a European framework.

1.2 Safe products and work equipment

The construction and design of products and, in particular, work equipment that are safe, healthy and fit for purpose forms an essential basis for prevention. The aim is to ensure, as far as possible, that only safe products are put into use. In this respect, however, the globalisation of production and distribution processes constantly leads to new challenges. Time and again, there are products on the market for both industrial and private use that cause serious hazards. The BAuA's projects aim to clarify the complex information available and to identify focal areas for action with regard to prevention. Based on this, the BAuA is committed to supporting designers and manufacturers in the development and production of products and equipment that are safe, healthy and fit for purpose.

1.2.1 Construction and design that are safe, healthy and fit for purpose

To support the construction and design of products that are safe, healthy and fit for purpose, one requires detailed knowledge of the associated risks. The evaluation of data on hazardous products on the market is one essential source of information. In 2012, the reporting system RAPEX (Rapid Exchange of Information System), which is supported by the BAuA, recorded more than 2,000 reports of products that entail a serious danger for safety and health. However, it has so far only been partially possible to evaluate the risks based on the available data and sources of information for products on the market, as there are significant gaps in the available information. In order to identify and name priority risks for the purpose of directing market-surveillance activities, the available data must be systematically expanded.

The aim is to expand the process of systematic product-defect evaluation and to derive risk-specific focal areas for action for technical work equipment and products.

To effectively help create products that are safe, healthy and fit for purpose requires closer consideration of critical parameters during the process of design and development of technical work equipment.

A needs-based determination is necessary as a first step in this direction, along with further development of hazard-specific limit values, parameters, measurement and assessment procedures (including for standardisation), and protective measures. New safety-related solutions in process-control engineering will also be investigated, along with safety equipment on machines and systems.

Subsequent implementation work will entail integrating the safety- and health-protection requirements directly into virtual product-development tools (CAD, virtual-reality systems), as well as the development of internet-based tools. Furthermore, it will be examined whether and which teaching and learning concepts on the topic of product safety are suitable as an early prevention measure in order to integrate requirements for the design of products that are safe, healthy and fit for purpose into the training of machine designers and product developers.

The development projects aim to support designers in their tasks with current, easy-to-handle media. For this purpose, target group-oriented, software-based instruments, such as design aids and guidelines, will be developed.

2 Adapting working conditions to the needs of humans

In the upcoming programme period, BAuA's research and development activities will also focus on the opportunities and risks of new forms of work and new technologies, as well as hazardous factors in the workplace. Building upon the results of 2010–2013 research and development program period, the new program concentrates on proceeding research tasks relating to mental and physical load, physical factors in the working environment, as well as chemical and biological hazards.

The observation of current technological developments and acritical analysis of the impact of new technologies remain a key objective for BAuA. Furthermore, within the programme period, BAuA intends to introduce results from the last research period into committee work, e. g. development as well as revision of technical rules, but also the development of guidelines related to specific topics intended to support companies in assessing hazards and in improving the socio-technical design of work systems.

2.1 Innovative technologies related to work equipment and systems

Technological innovations are a key factor in companies' competitiveness. As shown by previous results from the "Ambient Intelligence" (AmI) research focus from the preliminary research period, innovations can produce chances but also risks regarding safety, health and well-being of employees.

Upcoming AmI research area will focus on methods and concepts for computer-assisted work systems that help employees in their daily work context specific to the context and even, in part, autonomously – so-called adaptive work assistance systems (AAS). As networked units, current adaptive work assistance systems represent a subsection of cyber-physical systems, which are essential elements of the "Smart Factory" vision. They are a fundamental basic of innovative production technologies, as described in the German federal government's "Industry 4.0" future-oriented perspective.

BAuA's research aims to assess technology impacts at an early stage in order to improve these technology-driven developments in each instance regarding a humane work design and to avoid deskilling, loss of competence, mental overload, as well as other safety-related risks. As adaptive work assistance systems offer new possibilities for designing work in a flexible and customisable manner at the same time within the programme period, these possibilities will be considered from the perspective of designing work in line with age and the ageing process. Furthermore, the knowledge obtained so far on integral approaches to work design in terms of the cooperation between man, technology and organisation will be analysed – including its impacts on social and communicative processes.

2.1.1 Opportunities and risks of adaptive work assistance systems (AAS)

Adaptive work assistance systems support employees in performing their activities by taking into account situational context factors, e. g. the working environment, as well as individual parameters, such as knowledge and skills. The use of these systems (e. g. head-mounted displays) can be associated with specific physical and mental loads, as shown by results of lab experiments obtained by BAuA. It is objective to better understand the fundamental mechanisms of such systems (e. g. effects of dynamic lighting systems and climate control systems) in order to be able to give recommendations for the design of such systems, e. g. in technical regulations and standardisation. Furthermore, during the programme period, research will increasingly focus on the use of AAS in industrial practice in order to obtain further information on safe and stress-optimised application in daily live in industry.

The aim is to obtain more precise information on chances and risks associated with the use of adaptive work assistance systems. BAuA is committed to point out risks to the safety and health of employees and to support the design and use of AAS as to allow dynamic optimisation of stress and strain and better accomplishment of work tasks.

After fundamental questions (e. g. on the data processing of vital parameters and on data privacy issues) were clarified in the last programme period, the focus of this research field will be primarily on the interactions regarding to human information processing. Furthermore, the potentials of innovative technologies for improving communication between employees during their daily work will be analysed. In the new programme period, therefore, consequences for service as well as office and knowledge work are systematically considered.

2.1.2 Innovative design of sociotechnical systems

Considering the “human” factor in the work systems is an established approach since the introduction of the socio-technical design. Today, however, the focus is not only on innovative forms of human-technology interfaces, but also on effects for the surrounding social and organisational system. BAuA’s development activities therefore will concentrate on three aspects: the analysis of human-technology interaction with methods based on digital (computer-aided) ergonomics, the collaboration of humans and machines within the same work system, of the organisational aspects related to the concept of resilience engineering.

The aim is to identify factors of innovative work systems that contribute to the design of safe and healthy work equipment as well as work systems building on this, to develop practical concepts for companies.

Customisable and flexible work equipment as well as work systems which adapt to the context enable a better management of the extensive requirements arising from increasing complexity of processes and heterogeneous work forces. The development of computer-based methods for a virtual evaluation and design of work systems (digital ergonomics) can significantly support companies in this context.

Collaboration between humans and machines within the same work system creates challenges regarding the distribution and understanding of information and knowledge. Central to this are, for example, concepts of so-called “shared mental models”, which can help specify the shared understanding of workflows and distribution of tasks between humans and machines.

So-called resilient organisations are another focal area: thanks to resources that can be deployed flexibly and situation-based safety behaviour in addition to rule-based decisions, these robust systems are supposed to respond safely to unexpected occurrences in a dynamic environment, avoiding loss of control and therefore protecting the safety and health of employees. BAuA intends to contribute to a better understanding of basic principles of organisational resilience and to the development of practical concepts and guidelines for their implementation.

2.2 Mental workload: stressors and resources

The Stress Report Germany 2012 shows that work intensity, i. e. the time demands at work but also the required speed and quantity of work, is one of the stress factors most frequently mentioned by employees. At the same time, the findings of the GDA umbrella evaluation show that only half of the companies surveyed perform a risk assessment that takes into account mental load.

Important developments and also problem areas in the working world have therefore been described, and the BAuA intends to analyse these in greater detail within the programme period based on results obtained in the previous R&D programme's research field "Mental load and new forms of work". Based on the Stress Report 2012, two essential aspects from the spectrum of mental load and resources relevant to the design of work will be investigated, namely work intensity and rest breaks and recovery.

2.2.1 Work intensity and recovery

Time and performance pressure is considered a key load factor in today's working world, especially with the increasing significance of service work. Relations between high work intensity and health impairments have been widely analyzed. Less research has been carried out into how different influencing factors interact in the workplace and how related concepts for healthy and productive work might look. In the analysis of the conditions under which time and performance pressure arises, the aspect of "healthy leadership" has to be considered. Managers should also be included as a target group: because managers are, on the one hand, themselves affected by exceptionally high levels of time and performance pressure and, on the other hand, exert a significant influence on the load and health of their employees through their leadership behaviour.

The contexts relating to the emergence of time and performance pressure, and the way this is handled in the workplace, are to be further clarified in order to establish a basis for deriving design measures aiming at the reduction or productively handling of time and performance pressure, taking into account the working conditions as well as individual strategies and capacities to exert influence.

The design of rest break and recovery is one important aspect within the framework of investigating work intensity. The existing principles for designing rest breaks essentially apply to physical work and are formulated in a rather technical manner, i. e. they specify aspects relating to e. g. the time-related location and distribution of rest break times that are necessary for physical recovery. Relatively little is known, about recovery from mental work or work requiring interaction with people and the regulation of emotion. For example, current knowledge on how breaks can contribute to recovery in the case of service work and on what is to be taken into account in their design is, as yet, unsatisfactory.

For this reason, the effects of breaks – including consideration of age-related aspects – on recovery, performance, stress and strain in activities that are primarily characterised by complex mental work and by interaction work in the services sector shall be further investigated.

Furthermore it has to be clarified why employees only take breaks in an insufficient manner, what factors protect against this form of spill-over, what expectations employees have of recovery, and what techniques they use to recover from work. Based on the results obtained, recommendations are to be developed for the design of recovery phases. Thereby, the BAuA intends to make a contribution to occupational safety and health, as well as to the maintenance and promotion of employability, given the ageing workforce and extended working lifetime.

2.2.2 Risk assessment of mental load

The risk assessment of mental workload represents a central instrument for dealing with mental load in the workplace. However, it is only implemented by a minority of small and medium-sized enterprises. Expert assessments as well as surveys of employers and work council members show that companies continue to experience a great deal of uncertainty with regard to the required action and a lack of knowledge of suitable procedures for assessing mental load. In the current R&D programme period, the BAuA will therefore commit itself to providing practitioners with further orientation and assistance.

Based on the findings of the technical book “Gefährdungsbeurteilung psychischer Belastung” (Risk assessment of mental load), as well as the GDA umbrella evaluation, further needs for action will be derived in order to better satisfy companies’ different needs, stakeholder constellations and conditions for action.

The focus is on obtaining further information on the conditions that determine the process of risk assessment. In addition to this, investigations will also be conducted into the handling of the topic and the approaches of different groups of stakeholders both inside and outside the company. The implementation of risk assessment of mental load is also to be analysed in selected companies of other EU countries in order to ascertain further information on suitable procedures and conducive framework conditions for carrying out a risk assessment of mental load. Finally, the BAuA intends to sensitise companies to the application of available instruments for recording mental load.

2.3 Biological and chemical hazards

In Germany, chemical and biological exposure in the workplace is still responsible for almost half of all recognised occupational diseases. On the one hand, this is the result of activities involving “bought-in” chemical and biological products. In addition, however, the formation and unintentional release of substances in the workplace as a result of working procedures and processes plays an essential role. Here, the usual sources of information for chemicals (labelling, safety data sheet) are not available to the person responsible for occupational safety and health when it comes to compiling the risk assessment. Recently, this has increasingly also affected workplaces that work towards sustainable development in the sense of the “green economy”, e.g. in the turnaround in energy policy and in recycling, using new or refined technologies.

Within the framework of this research, chemical and biological exposure is to be systematically determined in field studies and correlated to the health effects and the available occupational-safety measures. The results will be used for the development of specific guidance and in order to improve and expand existing concepts for risk assessment, especially the Easy to Use Workplace Control Scheme for Hazardous Substances (EMKG). Furthermore, for biological agents, contributions will be made to the development of laboratory methods for legally compliant evaluation of hazardous properties (classification according to the Biological Agents Ordinance). The activities in this area are intended to put state occupational-safety regulations into concrete terms and improve their implementation.

2.3.1 Health risks due to biological agents and through use of antibiotics in the animals husbandry

In Germany, more than 5 million employees have contact with biological agents in various sectors of the economy. Inhaled air is once again one of the main uptake pathways, although little is so far known about its actual composition, especially with regard to the biological agent content. Important foundations are therefore lacking for the risk assessment and the selection of appropriate occupational-safety measures.

Knowledge will be acquired on the stress and strain caused to employees by biological agents and antibiotics as a scientific basis for Technical Rules and guidance, and support will be provided for the classification of biological agents by developing in-vitro methods.

Field studies are to be used to clarify which types of exposure can be recorded using molecular biological methods. In the process, especially in-vitro cell-culture systems and immunofluorescence microscopy will be applied as methods for the systematic identification of the hazardous properties of biological agents in order to aid classification. Furthermore, research is to be conducted with the help of biomonitoring into whether the use of antibiotics in intensive animal keeping leads to health-relevant exposure of employees – including through development of increased resistance or colonisation with resistant pathogens. The results will be incorporated by the Committee for Biological Agents when preparing Technical Rules and will be used for the development of practical aids for risk assessment and preventive occupational health care. In this regard, the BAuA will continue to cooperate with other higher federal authorities, regional authorities and institutes of the accident-insurance organisations.

2.3.2 Safe working procedures for a “green economy”

The number of workplaces engaged in the manufacture of products, technologies and services that protect the environment and that are intended to conserve natural resources is growing steadily. In Germany, more than 1.8 million people are now employed in the “green economy”. Despite the positive image, however, these workers are often exposed to hazardous substances, and insufficient is known about the type, level and duration of this exposure to allow proper risk assessment.

The effectiveness of protective measures will be determined and evaluated at selected workplaces within the “green economy”. This will form the basis for standardised working procedures in order to protect against chemical and biological hazards.

In development projects, field studies are to be conducted for selected working processes, among others in the recycling industry and biogas production, in order to measure the exposure of employees in these workplaces, and standardised working procedures are to be derived for the purpose of protecting against health hazards. In the process, it is to be clarified what chemical and biological exposure occurs in individual recycling and processing activities, what connections exist between internal and external exposure, and which technological developments are relevant. In this regard, activities will be investigated both in recycling facilities for classical areas of production (e.g. impregnated railway sleepers) and in facilities for the recycling of modern products derived from newer technological developments (e.g. energy-saving lamps). The field studies will be conducted in cooperation with recycling associations and companies, as well as with national regulatory authorities and the accident insurance organisations.

2.3.3 Easy to Use Workplace Control Scheme for Hazardous Substances (EMKG)

The Easy to Use Workplace Control Scheme for Hazardous Substances is a guidance concept provided by the BAuA since 2005 for the systematic assessment of inhalative and dermal hazards posed by chemical substances and mixtures. The control banding concept has proven to be effective in practice and acts as a supplement to industry- and activity-specific aids from other stakeholders in the field of occupational safety and health.

By updating and expanding the EMKG and by increasing its interconnection with other concepts relating to the risk assessment, the raising of micro-entities' and small and medium-sized enterprises' awareness of chemical hazards is to be improved and a contribution is to be made to further increasing the proportion of companies that conduct a proper risk assessment.

The module for assessing fire and explosion hazards, published as a pilot version in 2012, and a new module for the storage of hazardous substances will be integrated into a new version of the EMKG (version 3.0). The EMKG's presentation and didactics will be adapted to modern communication technologies and the needs of the different target groups. Interconnection of the EMKG with other hazard factors in the workplace will be tested. The programme of field studies for the validation and further development of Control Guidance Sheets for activities involving the filling and transferring of solvents will be continued. In addition to the tried-and-tested cooperation with users, disseminators and experts on the EMKG, European partners are to be acquired.

2.4 Physical load, physical agents and working environment

As the report "Safety and Health at Work" (2011) shows, significant load factors at work include – now, as before – the lifting and carrying heavy loads, working in noisy environments, poor illumination and uncomfortable climatic conditions. The BAuA's development activities for the period 2014–2017 will continue the institute's work on the conception of hazard-identification procedures for physical load, as well as on the determination of physical parameters for assessing risk factors. In order to ensure that work equipment does not lead to health impairments, the BAuA will expand its series of decision-making aids intended to facilitate the purchasing of safe work equipment.

2.4.1 Development and evaluation of a package of methods for risk assessment in the case of physical load (key indicator methods)

Developed predominantly by the BAuA, the system of "Key Indicator Methods" (KIMs) is well established in Germany. This semi-quantitative screening method allows load to be assessed in a time-efficient manner if good knowledge of the activity to be assessed is present. Currently, the KIMs are only available for "Lifting / Holding / Carrying", "Pulling / Pushing" and "Manual Handling Operations". In practice, however, there is a need for methods for recording and assessing many different forms of typical work-related physical load on the basis of a unified assessment standard. Accordingly, the system of "Key Indicator Methods" needs to be expanded.

In parallel to the development of these new modules, the measurement characteristics of the KIMs shall be investigated. For evaluating the KIMs, advances in methodological data acquisition and processing open up new possibilities for recording and assessing physical work, especially postures and body movements, since load profiles, for example, can be measured objectively in high resolution over long periods of time.

Building on and as a supplement to the three existing KIMs, four new methods will be developed, namely for strain due to great exertion of force, constrained postures, full body work and for the integrated recording and assessment of different forms of strain (mixed work).

The work is planned within the framework of an already established cooperation project with the DGUV, which aims to develop unified national assessment standards for physical load with various levels of accuracy (coarse screening, specific screening, expert screening, workplace measurements and laboratory measurements applying digital human models). The development of the different KIMs is also included in the focus of the Joint German OSH Strategy for the reduction of work-related health hazards and disorders in the musculoskeletal field.

The existing methods for the objective recording of physical load are to be used in order to check the validity of the KIMs. Here, the plan is to use the system for long-term field measurements to record activity types such as standing, sitting, walking, etc. and to use the field measurement system for short-term data acquisition (over several hours) for the determination of, for example, selected body angles or forces. Based on the objective load data that will be collected, the aim is to examine the load classifications obtained with the revised or newly developed KIMs.

2.4.2 Determination procedures for parameters for the assessment of physical agents and conditions of the working environment

In workplace practice, risk assessments are often hindered by the complexity of the assessment of various physical agents of the work system. Parameters for noise, climate, optical radiation, mechanical hazards or ergonomics are, in principle, not easy to determine. Especially small and medium-sized enterprises often lack skills and resources, and, as a result, risk assessments are often not conducted or not conducted properly. Hence, substantial risks to employees can go undetected.

The objective is – continuing the work commenced in the previous R&D programme – to promote the development of practical workplace procedures for the determination of hazard-specific physical parameters for evaluating risks. Additionally, corresponding protective measures are to be derived.

Envisaged areas of application include, for example, the evaluation of welding workplaces with regard to non-coherent optical radiation and noise (in combination) and the determination of exposure to light in the working environment and workplaces with electromagnetic fields or LED lighting technology. In terms of methodology, this will be approached by developing models and calculation / evaluation procedures, which are also to be reviewed with regard to test theory.

2.4.3 Guidance and decision-making tools for the use of work equipment in the workplace

The variety and complexity of work equipment on the market and the various possibilities for designing work systems are the reason that safety and health are often not considered adequately when enterprises procure work equipment.

In consequence, respective risks can arise for employees. In the 2010–2013 programme period, work in this area delivered good exemplary results and allowed identification of new focal areas for actions which will be addressed in the new programme period.

The aim is to support buyers and decision-makers in companies in selecting safe, healthy work equipment that is fit for purpose in the workplace. In this way, hazards can already be reduced at the stage of selecting work equipment.

For this purpose, assessment principles and guidance will be developed for the procurement of safe, healthy work equipment that is fit for purpose, e. g. laser safety filters and LED lights. The BAuA's objective is to allow established findings in the field of occupational science to be used in the assessment of work equipment. Furthermore, parameters for the safety and health protection of work equipment, e. g. emission values of work equipment, are not easy to interpret and assess for buyers and market surveillance; the correct handling of information of this type therefore poses a challenge. Here, questions of the correct interpretation of labelling will be addressed in connection with workplace guidance.

3 Avoidance of work-related diseases – promotion of health and workability

Work in this activity field will focus on the continuation of activities aimed at clarifying the genesis of work-related diseases, especially in the musculoskeletal and cardiovascular systems, and, building on this, preventive approaches for the improvement of humane working conditions shall be developed.

A second focus will be on addressing relations between working conditions, mental health, cognitive performance and workability. In addition, conditions for successful Corporate Integration Management and aspects of safeguarding labour participation of older employees will be investigated.

3.1 Work-related disorders of the musculoskeletal and cardiovascular systems

Work-related musculoskeletal disorders (MSDs) are usually chronic disorders that are of high relevance due to their burden on social-security systems: MSDs cause the highest direct costs (treatment of disease) and high indirect costs (lost years of employment). Cardiovascular diseases (CVDs) are responsible for a large portion of morbidity and mortality in industrialised countries. Due to demographic development, both will continue to increase in Germany as a result of the ageing (working) population. The BAuA therefore continues to carry out research work in this area, making use of different approaches and datasets, namely systematic reviews, cohort studies, data from social security institutions, and the health-data archive Wismut. In order to assure the quality of results, this work is accompanied by methodological developments, especially of processes and techniques of evidence-based medicine and statistical methods for analyses of cohort studies (regression models).

3.1.1 Aetiology of work-related musculoskeletal disorders

In the working world, it is above all physical working conditions that lead to differing occupational loads on the musculoskeletal system. Demographic change the extension of working life and population-based changes in lifestyle pose further. Successful evidence-based prevention concepts in working world require knowledge of occupational factors influencing of the emergence of work-related complaints and disorders in the musculoskeletal system.

Work-related factors influencing of the emergence of complaints and degenerative disorders of selected sections of the musculoskeletal system that are currently being discussed among experts in the world of occupational medicine are to be clarified, and, building on this, specific prevention measures are to be derived.

It is planned either to conduct a series of systematic reviews or to participate in a case-control or cohort study with regard to selected diseases, specific work-related physical risk factors (e. g. application of large forces, repetitive manual activities, unfavourable postures or forced physical inactivity) or work-related psychosocial factors (such as time pressure and questions of work organisation such as job rotation and recovery periods). Exemplary the degree of risks attributable to population-based factors is to be estimated for selected work-related MSDs. Furthermore, digital human models are to be tested for the evaluation of health risks, as these represent a non-invasive methodological approach that is both particularly meaningful and ethical. These models shall be used to investigate whether the findings obtained in this way can contribute to the interpretation of findings obtained within the framework of epidemiological studies on musculoskeletal disorders.

3.1.2 Aetiology of work-related cardiovascular diseases

The potential work-related risk factors for CVDs include psychosocial factors, physical load and physical/chemical factors. Furthermore, discussion will also focus on prolonged phases of work-related forced physical inactivity (lack of movement), frequently associated with tiring forced postures, as potential causes for work-related CVDs. However, it has so far been barely possible to quantify either the work-related share of the risk or the potential for occupational prevention that can actually be realised. Especially in the area of psychosocial load in the workplace, the available research results do not allow evidence-based specification of individual risk factors. An important prerequisite for the development of specific prevention programmes is therefore not met. Furthermore, the implementation of targeted prevention measures requires knowledge on high-risk groups and the significance of the individual risk factors in different occupational groups.

The BAuA is engaged in identifying occupations and/or industrial sectors that are particularly affected, as well as work-related influencing factors with respect to diseases of the circulatory system, and to estimating the risks attributable to population-based factors for selected occupational loads.

Within this framework, the available literature is to be systematically evaluated for various, selected work-related risk factors, and attributable risks are to be calculated. Furthermore, population-based cohort studies are planned with participation by the BAuA: for example, the Gutenberg Health Study will be continued as a longitudinal study in order to investigate night-shift work, psychosocial workload and occupational biography characteristics with regard to their influence on CVDs. In addition, for prevention and intervention programmes specific to target groups, risk profiles will be investigated with regard to psychosocial workload, night-shift work and lifestyle for classified occupational fields and major occupational groups by way of in-depth analyses of occupational biographies.

Furthermore, occupations or industries particularly affected by CVDs are to be identified in further analyses of data from social security institutions (primarily statutory health insurance funds) in order to develop proposals for prevention.

3.1.3 Prevention of CVDs and MSDs in the workplace setting

Because there exist shared risk factors for MSDs and CVDs, both in the working world (heavy physical demands and psychosocial workload) and in the domain of lifestyle (physical inactivity, excess weight and smoking behaviour), many environmental as well as behaviour-based preventive measures in the workplace can contribute to the reduction of MSDs and CVDs. In this regard, primary prevention must address both the triggering factors and the influences contributing to the acceleration of physiological signs of wear caused by factors that can be modified. In addition to primary preventive approaches, secondary and tertiary preventive interventions also form an indispensable part of a comprehensive overall concept in the workplace. The desired identification and quantification of occupational risk factors and the identification of particularly affected groups of employees open up the possibility of developing and / or improving concepts of prevention and intervention. Because of the multifactorial genesis of most chronic MSDs and CVDs, the greatest success seems to be achievable through multimodal, theory-driven (e. g. stage-based or participative) prevention strategies.

A contribution shall be made to the evidence-based assessment and evaluation of the effectiveness of specific, complex, target group-specific prevention and intervention strategies for impeding MSDs and CVDs, especially in relation to environmental workplace interventions.

Making use of knowledge related to shared occupational and non-occupational risk factors for CVDs and MSDs, scientific evaluations of workplace prevention measures are to be systematically analysed with the aim of deriving recommendations for health promotion in the workplace. This includes participation in the development of selected occupational health guidelines. In order to facilitate scientific evaluations, instruments will be provided for the early recognition of individual risks for MSDs and CVDs in the workplace setting (e.g. early indicators for CVDs, updating the Nordic Questionnaire). Research collaborations will be sought for participating in high-quality methodological, multimodal studies of workplace intervention in order to scientifically support and / or evaluate complex workplace interventions.

3.2 Work, mental health and cognitive performance

In Germany, the mental health of employees is an important component of occupational safety and health, as is evident in, among other things, the fact that the programme of the Joint German Occupational Safety and Health Strategy (GDA) for the period 2013–2018 designates the protection and strengthening of health in the case of work-related mental load as an important objective. Accordingly, the BAuA will continue its research on selected mental disorders with relation to the working world, on cognitive performance and on mental demands.

3.2.1 Mental load at work and mental health

Mental health is increasingly considered as a continuum that extends far beyond functional limitations and mental disorders and that is also characterised primarily by features such as well-being, job satisfaction and work and individual related resources. For work design, knowledge of the mental health of the working population, and of the factors that can impair or promote mental health, is of great importance.

The increase of psychological diagnoses in incidences of incapacity to work, and the role of mental disorders as the most frequent reason for early retirement imply that mental-health disorders have acquired great importance for work. However, the available knowledge on the relations between new load constellations in the modern working world and mental-health impairments, especially mental disorders is currently insufficient. Future research will focus on types of disorder that are most likely expected to be caused by work-related factors and to impair workability. There are indications that this will most likely hold true for depression, burnout and impairments of cognitive performance.

The relations between mental workload and relevant mental-health disorders (depression / depressiveness, burnout and impairments of cognitive performance) will be analysed, taking into consideration the influence of mental disorders on employees' workability and functional capabilities.

The investigation of positive mental-health aspects has been intensified over the last two decades, albeit the focus has been on conceptual questions and psychometric measurement. A current systematic review conducted on behalf of the BAuA shows that very little systematic research has so far been conducted into questions relating to the causal effect, especially of influencing factors in the working world.

The BAuA's research aims to identify influencing factors for strengthening mental health and to investigate their effect on "positive" target variables of mental health such as job/life satisfaction and well-being.

Firstly, the state of the working population's mental health is to be ascertained based on an investigation of the distribution of mental-health indicators in the workforce. Information can also be gained on variables with a significant influence on mental health by investigating the relation between mental-health characteristics, on the one hand, and work-related and individual factors and employment history on the other. In order to obtain more information on the protective effect of mental health, further investigations shall be conducted on the relationships between positive characteristics of mental health and parameters of functional capability and workability. Furthermore, the relations between mental workload and mental disorders are to be explored in field and laboratory-based investigations. The data for these analyses is formed entirely by the dataset obtained in the BAuA project "Mental health at work" (S-MGA) within the framework of a representative survey of 4,500 employees.

3.2.2 Investigations into the development of cognitive performance with special consideration of work-related resources

The modern working world places high demands on employees' cognitive abilities. The increasing complexity of work tasks, increasing requirements for sustained attention and flexibility, and age-associated impairments can disturb the balance between requirements and cognitive performance prerequisites. The need to maintain workability over the entire working life particularly relates to the maintenance and development of employees' cognitive performance. Here, for example, the resources available in the workplace (job control, etc.) are considered to be essential, although their effect on cognitive performance remains unclear. This also applies to question such as which work and personal related factors influence cognitive performance, what relations exist between cognitive performance, the brain's information-handling processes as well as chan-

ges in cognitive abilities occurring over the working life.

It is also worth mentioning that activities involving large quantities of information become critical if the cognitive demands exceed the limits of human information processing. Peak demands of this kind can be determined by continuous, objective recording of mental workload via EEG signals while simultaneously surveying the cognitive demands. A method developed in the programme period for online recording of the mental workload determined via EEG signals will be further developed and tested under field conditions.

The relation between resources available in the workplace, cognitive performance and neurophysiological markers is to be determined. In addition to this, the influence of resources on the development of cognitive performance over time is to be determined in order to obtain information on the maintenance of cognitive performance.

3.3 Corporate integration management

The objective of corporate health management is to develop and establish health-promoting structures and to improve employees' health literacy. In principle, corporate health management activities can be assigned to one of three areas: corporate occupational safety and health, corporate integration management, and corporate health promotion. Of these, measures relating to occupational safety and health and corporate integration management are obligatory. Studies show, however, that deficits persist in the introduction of corporate integration management into workplaces – albeit both people directly affected and the companies respectively as well as society as a whole benefit from a coordinated return to work process (RTW), as this can lead to an improvement in employees' quality of life and a reduction of socioeconomic costs. In the field of occupational safety at work, particularly vulnerable groups deserve increased attention. Here, there is a need for research into, among others, the supporting role played by occupational physicians.

3.3.1 Corporate integration management and research on return to work

Corporate integration management approaches and return to work programs deliver an important contribution to prevention in the workplace. Both aim at restoring health and avoiding incapacity to work and possible chronification in order to facilitate further employment. So far, however, the implementation of corporate integration management has not been satisfactory. In particular, there is a lack of relevant scientific knowledge that would allow the derivation of supportive measures which are of practical use in the workplace.

The aim is to identify essential influencing factors for successful reintegration and the specific needs of employees suffering from diseases.

It will be investigated what individual, workplace-specific and operational factors influence retention or return to the work and what measures are necessary to support participation in working life. In the longer term, these findings are intended to lead to recommended courses of action in order to support the development of further-reaching workplace-oriented programs. In addition, existing RTW programs are to be evaluated via systematic reviews. The methods of evidence-based medicine are particularly suitable for this purpose; in this regard, especially approaches involving the integration of methods – i. e. the linking of qualitative and quantitative approaches – are to be refined in order to further improve the systematic utilization of the best available evidence and the assessment of the reliability of information and data.

3.3.2 Vulnerable groups

Workers with health impairments represent a vulnerable group requiring protection. Here occupational physicians play a key role in the maintenance and promotion of health and participation in employment. Their role must be optimised and subjected to further scientific analysis.

The objective is therefore to further investigate the influence of health on the working lives of young persons and the special role of occupational physicians in dealing with vulnerable groups.

4 Understanding the impact of a changing working world and developing further occupational safety and health instruments

The BAuA pursues the objective of systematically recording and analysing changing trends in the working world. This entails, in particular, the observation of overarching structural changes and trends that subsequently necessitate further development of work design knowledge in the field of occupational science and of prevention structures, which allows the subsequent development of customized concrete solutions and guidance. Another objective is to specify impacts on the need for modernisation and adaptation of prevention structures on the organizational level and beyond.

4.1 Increasing flexibility and restructuring

On the one hand, as a direct result of efforts by companies to increase flexibility, the proportion of employees in atypical types of working-time arrangements and in atypical employment has been growing strongly and steadily for a number of years. On the other hand, for an also increasing number of employees, working life has been detached from fixed working hours, work locations, and / or fixed affiliation with one company. This is accompanied by considerable and often rapid changes due to company restructuring measures, especially for employees that have not yet been affected by the aforementioned measures to increase flexibility. Whereas it is currently already foreseeable that flexibility as well as restructuring measures are frequently associated with negative consequences for the health and safety of the employees affected, the mechanisms underlying these negative effects are not yet sufficiently understood. In addition, the available knowledge is not yet sufficiently integrated. It is thus currently not possible to derive clear practical recommendations. Finally, there is currently a lack of sound prevention and intervention measures for protecting employees.

Through research and development projects, the BAuA is pursuing the objective to supplement current scientific knowledge concerning underlying processes, to integrate this knowledge in

a systematic fashion and thereby to arrive at an evaluation of opportunities and risks, as well as, finally, by way of example, developing and testing support instruments for managing the aforementioned measures.

4.1.1 Evaluation of risks and opportunities of flexible design elements in the context of new types of work and working-time arrangements

The number of employees engaged in atypical working-time arrangements (e. g., shift work, weekend work, permanent night work, etc.) has grown steadily over recent years. The same applies to the number of people for whom there is no longer a clear boundary of work and private life (dissolution of temporal and spatial boundaries). Such working-time arrangements are associated with specific risks but also opportunities (e. g., compatibility of work and family life) for employees that are not yet sufficiently understood, especially with regard to their long-term effects. Accordingly, the BAuA is pursuing the following objectives in this area:

Risks and opportunities of atypical working-time arrangements are to be analysed, and the effect of the dissolution of temporal boundaries between work and private life is to be identified.

The analyses are to be conducted partly through collaborations with companies that rely on corresponding atypical working-time arrangements. Further information in this regard could be obtained by comparing the burdens and opportunities facing employees in companies that have chosen to actively manage the challenges of dissolving boundaries between work and private life differently (e. g., by restricting access to company information in employees' leisure time).

4.1.2 Effect of restructuring measures on employees and development of support instruments for their management

Companies are responding to various factors that they cannot directly influence, e. g. increased competitive pressure or shorter product life cycles, by introducing restructuring measures at ever-shorter intervals. These measures are generally highly complex and difficult to manage. For this reason, restructuring measures often – and usually unintentionally – lead to high short-term burdens for employees and, in the medium term, can also contribute to negative effects on their well-being and health. These negative effects particularly concern certain groups in organizations, such as the middle management. Previous research results provide first indications of resources (e. g. transparent communication, process fairness) that could be used to design restructuring measures with less stressful consequences and fewer negative effects.

For this purpose, the mechanisms are to be investigated by which restructuring measures can affect the health and well-being of employees.

In addition, single support instruments that are used in workplaces, will be critically analysed and knowledge will be derived as to which measures and instruments may help groups of employees that are particularly affected to better manage the effects of company restructuring. For this purpose, the BAuA will seek to collaborate with companies from industries that are particularly strongly affected by restructuring (e. g., telecommunications industry, public administration).

4.2 Demographic change

The workforce in Germany is shrinking and ageing simultaneously, since age groups with a relatively low birth rate are currently in the first years of working life and age groups with a high birth rate are approaching retirement age. In order to maintain companies' and organisations' productivity and competitiveness in the face of demographic change, it is necessary to actively promote the health and productivity of employees and to increasingly recruit those parts of the population that are, as yet, poorly represented in the labour market. Previous research activities have investigated which individual aspects allow especially older employees to stay in the workforce for a longer time. In order to contribute to the successful management of the above challenges, approaches are also necessary that integrate these individual findings, especially the existing knowledge on age-appropriate work design, but also approaches that, in a targeted manner, generate knowledge on work characteristics that allow healthy ageing while in employment (ageing-appropriate work design). Finally, the systematic gaps in current knowledge that exist in individual sectors (e. g., the services sector) are to be filled through corresponding research.

4.2.1 Integrating and supplementing the knowledge on age- and ageing-appropriate work design

On the question of how work is to be designed in order to safeguard the health of employees up to retirement age and to allow them to participate fully in society, a series of individual measures of ageing- and age-appropriate work design have been discussed and investigated (e. g. specific working-time arrangements, ergonomic work aids for older persons). So far, however, there is no consolidated overall review that integrates these individual aspects and allows for the derivation of concrete concepts and recommended courses of action. Moreover, the related research is not complete, especially in relation to important influencing factors (e. g., work design as concrete leadership behavior) and central sectors (e. g., the services sector).

Accordingly, the aim is to provide systematic knowledge on age- and ageing-appropriate work design for stakeholders in the fields of occupational safety and health and politics.

For this purpose, current scientific knowledge on age- and ageing-appropriate work design will first be systematised and integrated. Furthermore, the BAuA will contribute to supplementing the available knowledge through its own research, e.g. on ageing-appropriate work design in the services sector.

In the course of this, it is also to be determined how participation in employment affects the health of older employees and, in turn, what influence health has on older employees' working capacity. For this purpose, both qualitative and quantitative studies will be conducted, partially on the basis of the German lidA cohort study. The findings are intended to support the derivation of measures for maintaining and promoting health and participation in employment in this group of employees, as well as the delivery of knowledge on age- and ageing-appropriate work.

4.3 Reporting on working conditions and systematic monitoring of data on work and employees

Current findings on the work domain (e.g., working conditions) and the workforce are indispensable for stakeholders from the fields of politics, economics and science, especially given the prevailing rapid and diverse changes in this area. These findings can form an important basis for discussions, evaluations and also decisions. Accordingly, it is necessary that current findings are provided on a continuous basis and with the necessary quality and reliability.

4.3.1 Systematic concept for reporting on working conditions and occupational health

The BAuA will continue to build up and expand its systematic concept for reporting on the working conditions and their effects on occupational health. For this purpose, the BAuA strives to continuously optimise the quality of its own data sources, which it uses for reporting. For example, with the BIBB/BAuA Workers' Survey, a current stock of data is already available to the BAuA for its reporting about the work domain. This data allows for far-reaching statements on, for example, the working conditions and stress and strain experienced by various groups of employees in various branches and industries.

The objective of providing the required information at a high quality standard will be pursued through activities related to reporting on the working world (e.g., through the report on Safety and Health at Work [SuGA] or the BIBB/BAuA Workers' Survey) and systematic monitoring of data from other sources.

In its own research projects, the BAuA will review and optimise, where necessary and possible, the quality of the indicators used to describe, for example, the working conditions in its own data stock from surveys. In addition, the BAuA will expand its reporting beyond tried-and-tested instruments such as the SuGA report and the BiBB/BAuA Workers' Survey (for example through the development of an integrated demography monitoring). In order to also make use of data stocks from other institutions in the context of "work", systematic tests will be conducted on the usability of available data. In the process, possibilities for cooperation will be explored, such as by integrating work condition indicators into other data collections (e.g., cooperation with the Robert-Koch-Institute).

4.4 Effects of instruments and measures of occupational safety and health

Especially against the background of changes in the working world, functioning structures of institutional occupational safety and health are indispensable: Together with workplace health protection that should be as comprehensive as possible, they are the prerequisite for safe and healthy work for employees. Currently, two fundamental deficits stand in the way of this ideal state of affairs: On the one hand, it is apparent that there is a serious deficit with regard to implementation, as few companies actually (completely) implement the required occupational safety and health measures, despite binding legal requirements. On the other hand, there is a knowledge deficit, as there are barely any research findings in relation to what the beneficial and impeding boundary conditions are for organizations' implementation of occupational health and safety measures. In addition, it is unclear which elements are responsible for the success of these measures.

4.4.1 Identifying the underlying mechanisms of prevention measures and of legal requirements with regard to safety and health at work

Companies are subject to legally prescribed occupational-safety measures. Currently, however, little research has been conducted on the factors that influence the actual implementation of these measures on the one hand and, on the other hand, which individual measures actually improve the safety and health of employees in workplaces. For example, elements of the legal requirements themselves, features of the inspection, characteristics of the organizations and / or an interaction of these three groups of influencing factors can have an effect.

The objectives are to investigate the reasons for the deficits in implementation and to generate knowledge about the mechanisms underlying occupational safety and health measures.

Firstly, the routes are to be analysed by which prevention measures and legal requirements deliver their effect. Furthermore, beneficial and impeding boundary conditions are to be identified in order to derive suitable recommended courses of action. With these activities, the BAuA is committed to the implementation of effective occupational safety and health measures at the company level.

BAuA project: Mental health in the working world – determining the current state of scientific evidence

Early retirement and incapacity to work due to mental disorders and diseases are increasing. Simultaneously, mental demands have been rising since approximately the mid 1990s. According to the current state of knowledge, it can be assumed that the changes seen in the working world play a part in influencing this development. In this regard, good mental health is increasingly becoming a prerequisite for successful and long-lasting participation in employment.

Correspondingly, humane work design that contributes to avoiding mental impairments and maintaining mental health and performance becomes a central challenge. In contrast there exists partly considerable technical ambiguity, with regard to the evaluation of effects of changes in work, especially requirements for cognitive and emotional performance.

In recent years various activities have been initiated in the field of safety and health at work, with the aim of avoiding mental impairments triggered by increasing mental demands and of maintaining employees' mental health and performance. Although there is a general consensus on a fundamental need for action in this regard, it is uncertain, especially in relation to the question of a possible and reasonable scope of regulation, to what extent current scientific evidence is sufficient to allow for a clear definition of possible hazards in their complexity and, furthermore, to allow the design of modern forms of work in a humane manner.

Therefore the research project "Mental health in the working world" aims at producing a broad-based and scientifically sound of the current state of scientific evidence with regard to mental load. The project focuses additionally on increasing objectivity in the socio-political regulatory debate and policy development. Not only potential hazards but also personality- and health-promoting features will be considered in accordance with the overall concept of humane work design. Overall, the project is intended to provide infor-

mation on how mental load factors and resources are to be evaluated with regard to the sound state of scientific evidence, what new work requirements result from changes in the working world, and what gaps exist in knowledge on new load constellations. Furthermore, the project aims at the identification of existing design concepts and measures. The project is divided into three phases, which will build upon one another.

Initially, in Phase 1, the available knowledge will be processed. For the mental load factors and resources in the working world, scientific review papers will be prepared on the available theoretical approaches, methods and studies. Thereby transparent, scientifically recognised procedures, e.g. systematic reviews, meta-analyses or scientific analysis methods with a comparable standard will be applied. Furthermore, expert reports will be commissioned in subject areas for which, although they are highly relevant to the matter in question, relatively few studies are available, such that the review papers would not be sufficiently informative. In total, the aim is to summarise the current scientific evidence on a scientifically recognised level.

Subsequently, based on these review papers, Phase 2 will entail organising symposia, to which renowned national and international scientists in the subject area will be invited. The findings will be published extensively. The aim of this phase is to establish an understanding of current knowledge that is considered to be sound. Furthermore, gaps in current knowledge are to be identified and outstanding research questions are to be specified, that – if of high-priority – will be addressed within the framework of the envisaged project duration and that – if of medium- and long-term perspective – will be transferred to a research agenda.

In the third and final phase, the results of the symposia will be discussed in detail with members of the relevant practical community such as occupational safety specialists, and with the representatives of social partners. In the process, the aim will be to incorporate the results of Phases 1 and 2 of the project especially into the GDA's focal topic of "Protection and strengthening of health in the case of work-related mental load"

in order to combine the knowledge acquired with the occupational-safety expertise of the social security institutions. Phase 3 therefore focuses on ensuring the necessary acceptance of the results in the occupational-safety community, as well as deriving possible recommended courses of action for mental health. In addition to reaching a fundamental understanding of objectives, priorities and measures, operational recommendations for adequate regulatory instruments are also to be explored in close cooperation with the Federal Ministry of Labour and Social Affairs (BMAS), such as concrete connecting factors for regulations within the framework of the work of state committees or focal areas for action for supervisors within the framework of the Joint German Occupational Safety and Health Strategy.

In summary, a scientifically sound overview of mental load factors is to be prepared, providing information on the current state of evidence on load effects that are harmful and / or beneficial to health, demonstrating the availability of measurement standards and the possibility of recommended threshold values for mental load factors, and describing the practice-oriented knowledge relating to health-promoting work design.

III

Framework conditions

1 Scientific cooperation

The BAuA uses its strategic national collaborations with departmental research institutions and other national and international institutions within the professional environment in order to maintain and increase the scientific quality of its research and development activities.

National collaborations with universities and other research institutions have been systematically developed and expanded in recent years on the basis of the BAuA Research and Development Programme for 2010–2013. The BAuA awards special significance to professional networking within the local scientific community at its various locations (Dortmund, Berlin, Dresden). In addition to this, cooperation agreements are in place with the University of Wuppertal, the Leibniz Research Centre for Working Environment and Human Factors (IfADo) in Dortmund, Berlin University Hospital (Charité – Universitätsmedizin Berlin), the Technical University of Dresden (TUD) and the German Statutory Accident Insurance (DGUV), which is the umbrella association of the statutory accident-insurance organisations. The aim of this cooperation is to strengthen joint activities in research, teaching, transfer of practical experience, and promotion of young researchers.

In terms of content, teaching activities focus on chemical safety and toxicology, hazardous-substance management, occupational medicine, epidemiology, product safety, and occupational-safety law. Work towards qualifications by young scientists – primarily dissertations but also bachelor's, master's and diploma theses, as well as

student internships – is supervised by scientists from the BAuA, in some cases with participation by the BAuA's laboratories. Furthermore, the BAuA is a training institution for the medical specialism "Occupational Medicine" with authorisation to provide training for a period of 12 months.

Within the framework of research and development, further national collaborations exist with regional and national authorities (especially the Federal Institute for Risk Assessment BfR, the Federal Environment Agency UBA, the Robert Koch Institute RKI, the Federal Institute for Vocational Education and Training BIBB and the Federal Institute for Materials Research and Testing BAM), the German Statutory Accident Insurance Institutes for Occupational Safety and Health IFA, for Work and Health IAG and for Prevention and Occupational Medicine IPA, and the organisations of the social partners in the field of occupational safety and health.

In the performance of specialist functions relating to safety and health at work, the increasing Europeanisation or internationalisation of many processes and decisions in the social, environmental and economic domains, and hence the related common interests on the part of the occupational safety and health institutes and players in the EU member states, give rise to the rapidly growing need for an international commitment of the BAuA. For example, the institute is an active member of the European research association PEROSH (Partnership for European Research in Occupational Safety and Health), which was founded by the leading European occupational-safety institutions to promote

cooperation and to facilitate and support the attraction of third-party funds. Scientists from the BAuA participate in various PEROSH working groups, in which scientific knowledge is collated on selected focal topics in occupational safety and health (e. g. nanotechnology, psychosocial loads, physical loads) through, among other approaches, European academic discourse, systematic reviews and joint research projects.

Within the framework of R&D activities by the European Agency for Safety and Health at Work (EU-OSHA, Bilbao), the BAuA has been closely involved in the work of the topic centre for “Occupational Safety and Health” (TC OSH) since 1999 for the purpose of recording and processing current research results and examples of good practice from companies. For example, it collaborates in projects of the European Risk Observatory (ERO) aimed at identifying risks arising in the field of safety and health protection at work and continuously determining joint research priorities (OSH Research Priorities) in order to improve early implementation of effective prevention measures.

The BAuA is a WHO Collaborating Centre for occupational health and contributes to the implementation of the “Global Plan of Action on Workers’ Health” through its own projects. Furthermore, it also cooperates with the International Labour Organisation (ILO) in Geneva.

Through stepped-up participation in, among others, the European Framework Programme for Research “Horizon 2020” from 2014 onwards, as well as in national support programmes of the BMBF, within the framework of its strategic R&D priorities, the institute will seek further strategically significant collaborations with European universities and research institutions and to attract greater levels of third-party funding. In addition, the BAuA – together with the BMAS – will also strengthen its commitment to agenda-setting within the framework of the Joint Programming of the European Research Area (ERA). It is already active in the Joint Programming Initiative “More Years, Better Lives”.

2 Resources and equipment

Because of its limited human resources and the sheer quantity of its other responsibilities for safeguarding high-quality scientific results, the BAuA must take advantage of all opportunities for concentrating content and optimising workflows. At the same time, it must ensure through suitable personnel development that, on the one hand, current expertise is incorporated into technical work and, on the other hand, long-term competence development is promoted.

The proportion of the BAuA’s technical activities that are dedicated to research and development, currently at 27%, has developed in recent years and is not to fall below 25% in future. On the costs side, the BAuA’s annual direct expenditure for research and development comes to a total of approx. 12.6 million euros, of which about 9 million euros are spent on personnel costs and 2.6 million euros on orders placed with third parties. The proportion of posts in senior civil service has risen to 41% from 34% in 2009. This proportion is to be stabilised in coming years in order to meet the increased quality requirements of all technical fields of responsibility on a permanent basis. In total, 106 full-time equivalent posts – with 170 employees – will be allocated to research and development at the BAuA in the programme period. The proportion has therefore been increased by approximately 40% when compared to the previous programme.

Some two thirds of the increase in personnel for R&D tasks was achieved by creating additional temporary employment opportunities for young scientists, who are deployed in R&D projects at the BAuA. These opportunities at the BAuA for temporary employment of scientific personnel are also to be utilised in future. The BAuA thereby intends to promote continual research innovation with regard to content and methodology by incorporating young scientists and, at the same time, to achieve longer-term, systematic recruitment and personnel development. Creating a special budget item for project-specific employment of young scientists for R&D tasks already proved to be an efficient instrument for this in the last R&D programme. The BAuA currently spends approx. 850 thousand euros a year on this

young-scientist budget item, which accounts for some 16 people. In addition to this, greater use is to be made of temporary employment as an additional option on the basis of acquired third-party funds. So far, this employment model has already been used for a yearly average of approx. 18 temporary young scientists.

One of the BAuA's objectives is for a large part of this employment group to be working towards a scientific qualification (especially a PhD, in some cases also a postdoc qualification) and receiving technical supervision from experienced BAuA scientists. For example, the number of ongoing PhDs rose from 11 in the year 2010 to 20 and 22 respectively in the years 2011 and 2013, primarily through increased employment of young scientists.

Projects funded by third parties are of great significance overall for the continuing development of scientific competence at the BAuA and for the institute's ability to innovate. At the same time, such projects are an important indicator of the Federal Institute's technical integration into the scientific community and of the significance of its scientific projects and results. Projects funded by third parties present an excellent opportunity to acquire qualified personnel and to expand strategic collaborations with national and European partners. For this reason, the scale of third-party funding acquired for the realisation of programme objectives in the fields of research, development and transfer is to be considerably increased during the programme period, after the essential foundations were laid in the last programme through the establishment of new R&D lines.

The measures for departmental research decided by the Federal Government and based on the Freedom of Science Act open up the possibility of flexible personnel management for federal departmental research institutions. The BAuA is monitoring developments at other federal institutions and will, if necessary, present proposals for further suitable measures for strengthening the professional profile.

The BAuA maintains its own scientific laboratory capacities for its research and development projects. For the development section, larger laboratories exist for evaluating the safety of products and work systems and /or measuring hazardous substances at workplaces. In the sections that focus primarily on research, the laboratory capacities, which are more specialised in some cases, are assigned directly to the individual specialised groups and integrated into their responsibilities.

3 Process and quality management

The content of research and development projects is aligned with the fields of activity of the strategically oriented R&D programme, and the achievement of this programme's objectives is recorded and evaluated on an annual basis. A great deal of the content in the fields of activity has thematic connections that extend beyond the limits of the respective programme priorities and is coordinated between the specialist groups involved during the planning and realisation of projects. Collaboration by the different stakeholders within the BAuA is organised into defined processes and interlinked across the BAuA in order to achieve efficient project management in line with the strategic orientation.

The BAuA's research and development council is the internal technical control and steering body responsible for strategic orientation of research and development, as well as quality assurance of R&D processes and their results. Led by the BAuA's research and development director, it comprises the scientific directors of the four specialist areas with R&D tasks and the head of the BAuA staff office for strategic R&D management.

Programme development and the long-term setting of priorities in the field of research and development are supervised by the BAuA's external Scientific Advisory Board. This advises the BAuA with the aim of ensuring scientific work is performed to an internationally recognised technical standard. Renowned experts both from universities and from large-scale and departmental research institutions are represented in the Scientific Advisory Board.

Research and development processes at the BAuA are arranged using action and decision-making models to deliver effective and practicable steering and evaluation based on the BMI's best-practice guide "Projektmanagement für die öffentliche Verwaltung" [Project management for public administration]. In light of this, projects' work phases and decision-making stages are mapped for the overall process of planning (brainstorming, project definition, detailed planning) and execution (implementation, closure / handover) and associated with corresponding quality-assurance steps.

At the core of the quality-assurance system for processes and results is a series of measures that facilitate both efficient project planning and execution, on the one hand, and effective operational controlling and evaluation for projects and programmes on the other:

- technical discussion and selection process in project identification and preparation over multiple stages;
- extended project planning (milestone scheduling, environment and risk analyses, success criteria);
- cost-utility consideration for all R&D projects;
- regular presentation of selected project content and results in the BAuA's scientific seminar series;
- publications in relevant specialist journals (esp. peer-reviewed);
- presentation of findings at conferences and specialist events of the scientific communities and specialist societies;
- promotion of scientific qualifications.

The selection of research and / or development topics for the structuring and implementation of the R&D programme is based on priority-setting criteria that are directly linked to the BAuA's range of technical responsibilities. One of the BAuA's unique features as a departmental research institution is that it operates at the interface between science, politics and industry, taking account of these target groups' often differing requirements. The prerequisite for departmental research is a corresponding need for action with regard to organisational measures on the national level. In the field of occupational safety and

health, technical priorities are set primarily from the point of view of (identifiable or presumed) risks and opportunities for safety and health. In this respect, it must be weighed up – even with regard to the future – whether and to what extent there are knowledge deficits or existing knowledge is not implemented to the necessary extent in practical design and practical actions in occupational safety and health. Equally, account must be taken of a topic's level of national, European or international significance, and of what innovative and promising approaches can be used – in which technical collaborations – to achieve the objectives. Finally, it is also necessary, via a strategically controlled combination of continuity and innovation in the contents and resources of research and development, to safeguard the performance of the BAuA's R&D potential in terms of the necessary breadth and depth of its technical approach.

The criteria for the selection of focal areas and topics of the BAuA's research and development stand against the following background:

- the size of the identifiable or presumed risk to safety and health at work;
- the existing need for knowledge as a prerequisite for technically justified, goal-oriented preventive action;
- the topic's overarching social, environmental and / or economic significance;
- a European dimension to the topic within the framework of EU strategies, the EU Framework Programme for Research and the research associations in the field of occupational safety and health;
- identifiable deficits in the implementation of existing knowledge;
- the safeguarding of occupational safety and health policy's future capacity to act in connection with new serious challenges of the changing working world;
- novel and integrative solutions for health and safety at work;
- the maintenance and further development of scientific skills at the BAuA with the aim of providing competent policy advice to a competitive technical standard on a continuing basis.

4 Evaluation

In order to evaluate the strategic orientation and programmatic arrangement of research and development at the BAuA, these must be formulated on the basis of objectives. This is necessary to allow the medium- and long-term effectiveness of the programmatic research and development activities to be recorded and evaluated for the purpose of deriving future fields of activity and of constantly improving processes and results.

The programme evaluation primarily relates to the process of reviewing results within the focal areas and fields of activity of the R&D programme, based on general indicators for the significance of scientific work and / or for the occupational-safety benefit of practice-oriented developments. For this purpose, a series of indicators are recorded and analysed within the framework of the BAuA's registration and reporting activities. These relate both to the parameters generally accepted in the scientific community and to indicators for the results' occupational-safety benefit, i. e. their implementation, distribution and effectiveness. In each case, these parameters and indicators are weighted according to the character and objective of the research or development project with regard to the:

- number of publications (and how many of these are peer-reviewed);
- degree of distribution of the publications (circulation, sales, demand, downloads, media presence);
- level of third-party funding acquisition;
- number of scientific events;
- number of talks/presentations (and how many of these are invitations);
- number of academic graduations;
- number of collaborative projects (international, national);
- incorporation of findings into rules and regulations.

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