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VBG Expertise

Safety in Research

Handbook for research institutes and research projects

The solutions presented in this publication do not exclude other, at least equally safe solutions that may be outlined in the rules of other member states of the European Union, Turkey or other contracting states of the Agreement on the European Economic Area.

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Safety in Research

Handbook for research institutes and research projects

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Preliminary remarks

The guideline “Safety in Research” provides information and practical advice for a successful health and safety organisation in your research institute and in research projects. It is intended for everyone involved in the development and execution of research projects, especially the management of the institute, research groups, laboratories and projects. The guideline not only helps to establish and improve the health and safety organisation, but also to clearly define and assign tasks and responsibilities concerning health and safety.

This guideline sharpens your awareness of the multitude of workplace hazards in research institutes. It highlights how varied, broad and important an evaluation of work conditions is. This evaluation involves many experienced professionals such as managers, safety experts and safety representatives. They work together on the assessment of hazards in the health and safety organisation. The guideline also provides an overview of the contents as well as information for further reading.

Chapter 1 covers the setup of a legally compliant health and safety organisation for research institutes. This chapter is mainly intended for institute management and executives. The organisational structures of research institutes are as varied as the institutes themselves. They range from purely commercial to public companies and municipal or state-funded organisations and institutes. In this guideline, the term “management” or “institute management” is used as an equivalent for the term “employer” commonly used in health and safely.

Chapter 2 addresses the planning and organisation of research projects. It presents the steps required for health and safety in the course of a research project. This includes aspects such as the evaluation of work conditions, requirements for employees, safe work equipment and a safe work environment. Hence this chapter is aimed at people responsible for organising and executing research projects. They include project managers and the leaders of research groups or laboratories.

Chapter 3 provides information about requirements for the infrastructure of research institutes. It covers the handling of dangerous substances and biological agents, inspections of work equipment and the safe use of facilities, test setups and lasers. Accordingly, Chapter 3 is intended for the people responsible for the organisation and safe execution of research projects. They include institute management, project and laboratory managers, and also people who work independently in research projects.

Whenever possible, English source material and further reading is provided. Sadly, not all publications are available in English. In these cases, links to the German publications are included.

1 Organisation of health and safety

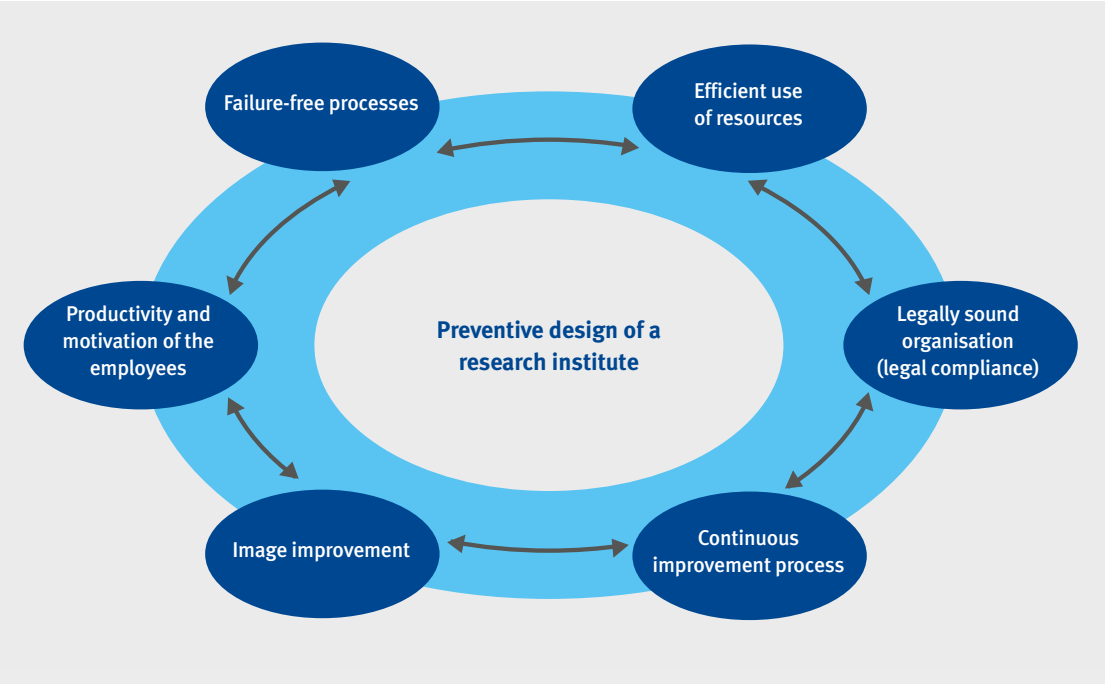


Figure 1: Preventive design of a research institute's work system

The health and safety of employees in research projects are key requirements for successful project realisation. Employees, both internal and external, have to be confident that they will not be exposed to any unusual hazards.

Institute management has to implement effective health protection and occupational safety measures to accomplish that. This is a challenge. As shown in Figure 1 "Preventive design of a research institute's work system", the following aspects mutually influence each other: The preventive design of a research institute influences its legally sound organisation and the efficient use of the available resources. This in turn affects the productivity and motivation of the employees, and contributes to failure-free processes and ultimately to a positive image.

Certain conditions in research institutes make implementation more difficult and affect safety. Examples are tight schedules, changes at short notice, high employee turnover and guest researchers. Economic factors, like limited project resources and the need to raise external funds, also have an impact on work conditions. This results in great responsibility and mental stress for everyone involved and in charge.

It is therefore essential to clearly organise all fundamental structures and processes in your institute. Doing so helps avoid risks and save energy, time and costs in all research projects. By observing the following notes regarding "company organisation", you also meet your obligation to implement the safe organisation of work in accordance with health needs.

1.1 Management and responsibility in the research institute

Occupational accidents and the impairment of employee health disrupt operating procedures and can be costly. This makes integrating health and safety in the organisational processes all the more important. Managers play a special role here and have to lead by example. They bear responsibility and draw attention.

Everything they do helps shape the culture of prevention. They have the power to initiate and drive cultural change to improve health and safety in the institute. Examples include advocating for a safer, healthier work environment, a positive working atmosphere and the constructive handling of errors in the research institute.

1.1.1 Organisational structure

The organisational structure of research institutes, and thus how the areas of responsibility are structured, can vary considerably depending on the type of institute, field of research and structure of the research projects.

Organisational structures are defined by the tasks and the type of institute. Operational processes or workflows as well as technical prerequisites and the available space shape the organisation. Accordingly, general basic principles for the organisation of health and safety are presented here. Beyond that, information on the preventive design of research projects is presented in Chapter 2.

Introducing a health and safety management system such as Systematic Health and Safety (Arbeitsschutz mit System (AMS)) of the VBG, helps with organisation. It is a way to reach the following goals:

- Making the work conditions in the institute as safe as possible, thereby
- improving the satisfaction and reliability of the personnel and
- contributing to the institute's success.

FURTHER INFORMATION

Systematic Health and Safety

Chapter 2 Organisation of research projects

1.1.2 Health and safety starts at the top

Regardless of the organisational structure, institute management always bears the overall responsibility for health and safety. Be sure to establish, for the execution of every research project, who in the project is responsible for employee health and safety. Note that the overall responsibility always remains with institute management.

1.1.3 Transfer of obligations to competent persons

Institute management can transfer health and safety obligations to competent, reliable persons such as the managers of departments and teams. In the transfer of employer obligations (Organisationshilfe – Pflichtenübertragung), the areas of responsibility and authority must be defined exactly and documented in writing. In addition to assigning responsibility, the required resources (personnel, time and financial) have to be provided. While the transfer of obligations distributes responsibility among several people in principle, institute management retains the overall responsibility, in particular for selection, organisation and control; see Chapter 1.1.4.

FURTHER INFORMATION

"Transfer of employer obligations"

1.1.4 Responsibility

Regarding the responsibility and obligations of institute management and the person in charge assigned by management, health and safety is broken down as follows:

Organisational responsibility: Establish an operational organisation with clear rules for safe workflows and facilities. Define the necessary protective measures, have them implemented by responsible persons and regularly verify their effectiveness. Organisation includes, for example, preparing standing instructions, directives and work rules as well as informing, instructing and training personnel.

Selection responsibility: Always select personnel based on suitability. Instruct and deploy personnel according to the acquired qualifications. When awarding contracts to external companies, select contractors with corresponding qualifications.

Controlling responsibility: Review whether the planned organisation is functioning. Check if the persons in charge are suitable for its implementation and meet their assigned obligations.

Technical responsibility: Purposefully employ the knowledge and experience of your specialists. For instance, have them assess possible hazards in their specialist field and make them personally responsible for safe work practices.

1.1.5 Operational health and safety organisation

Maintaining and improving the health and safety of employees in the research institute is the overriding objective. An appropriate and functioning health and safety organisation is a basic prerequisite. As institute management, you have to ensure the sound and effective organisation of work and provide **safety-related support and the care of a company doctor** according to DGUV Regulation 2 "Occupational physicians and OSH professionals" (DGUV Vorschrift 2). Various models exist for this support and care, depending on the number of employees. For details, see DGUV Regulation 2 and the VBG Information "Effective use of safety-related support and the care of a company doctor" (Sicherheitstechnische und betriebsärztliche Betreuung).

If your institute has more than 20 employees, you are required to:

- Select **safety representatives** in the required number, enable their training and appoint them. The required number depends on the proximity in terms of space, time and expertise of the safety representatives to the employees, the occurrence of accidents in the operation and the number of employees. The Safety representative calculator (SiBe-Rechner) is a useful tool for determining the number of safety representatives.
- Establish a **health and safety committee** and convene this committee quarterly. It consists of:
  - Institute management or a person authorised by management
  - Health and safety officer
  - Company doctor
  - Safety representatives
  - Employee representation
  - Other experts consulted as needed, such as the dangerous substances officer, biological substances officer or radiation protection officer (also see Chapter 4).

Institute management is responsible for **evaluating the work** conditions (hazard assessment), Act on the Implementation of Measures of Occupational Safety and Health to Encourage Improvements in the Safety and Health Protection of Workers at Work (Arbeitsschutzgesetz, ArbSchG). The hazard assessment is the central occupational safety tool. Make sure that the hazard assessment is completed, and that effective measures are established and implemented. Appoint suitable, qualified people responsible for implementing and verifying the effectiveness of the established measures. These may be the department and project managers, supported by the health and safety officer, company doctor and technical representatives. For more information about the hazard assessment, see Chapter 1.3.

LEGAL BASIS

- Measures of occupational safety and health Sections 3, 4, 7, 11, 13
- DGUV Regulation 1 Sections 2, 13, 15, 16 "Principles of Prevention"
- DGUV Regulation 2 "Occupational physicians and OSH professionals"

FURTHER INFORMATION

- VBG Information "Effective use of safety-related support and the care of a company doctor"
- Safety representative calculator

Chapter 1.3 Evaluation of the work conditions

Chapter 4 Overview of specialists and persons in charge at research institutes

1.2 Personnel

Selecting and deploying personnel are key success factors for research projects. Managers must be able to select, deploy and manage suitable personnel. Ensure the responsible deployment of personnel, for example, through continuing education for managers. The VBG assists you with continuing education for managers with a broad range of seminars; see VBG seminars (VBG-Seminare für Mitglieds-unternehmen).

FURTHER INFORMATION

VBG seminars

1.2.1 Personnel selection

To avoid the specific hazards in research institutes, institute management has to plan and realise research projects with appropriate personnel. Staff must have the experience and qualifications to carry out activities in the research project in a safe and healthy manner. This is essential for conducting research safely and in compliance with the law.

LEGAL BASIS

- Measures of occupational safety and health Sections 4, 7
- DGUV Regulation 1 Section 2 “Principles of Prevention”

1.2.2 Assignment of tasks

Define the assigned work tasks in writing with everyone in your area of responsibility. Describe how to complete them in a safe, healthy and quality-conscious manner. This includes establishing who makes what contribution to evaluating the work conditions.

LEGAL BASIS

- Measures of occupational safety and health Sections 3, 4
- DGUV Regulation 1 Section 2 “Principles of Prevention”

1.2.3 Preventive occupational medicine

Preventive occupational health measures are designed to maintain employee health and productivity. They include the hazard assessment, occupational medicine advice for staff and everyone involved in health and safety, occupational health precautions and company health promotion. The hazard assessment lays the foundation for appropriate occupational medical care. Preventive occupational medicine allows health risks resulting from an activity and deficits of existing protective measures to be identified in a timely manner.

Institute management either has to initiate (= compulsory preventive care) or offer (= recommended preventive care) preventive occupational medicine before the start of an activity and at regular intervals.

Depending on the hazards, preventive occupational medicine for research institute employees, see "Ordinance on Preventive Occupational Health Care" (Verordnung zur arbeitsmedizinischen Vorsorge ((ArbMedVV)), should be considered on the following occasions in particular:

- Activities with dangerous substances (for example, chromium VI compounds, isocyanates, nickel or its compounds, welding fumes, hardwood dust, epoxy resins)
- Activities with biological agents
- Activities with skin hazards (for example, working in wet conditions, wearing impermeable gloves)
- Activities with physical effects (for example, noise, strain on the musculoskeletal system including vibrations)
- Working at computer workstations
- Work stays abroad subject to exceptional climatic conditions and infection hazards
- Regular activities in low vegetation or direct contact with live (wild) animals.

Institute management also has to make preventive occupational medicine available to staff on request when a work-related impairment of health can be expected (= elective preventive care).

Preventive occupational medicine does not verify the fitness of a person for a certain activity. This is the purpose of fitness tests that must be carried out separately from preventive occupational medicine. Depending on the hazard assessment, these include tests, for example, for driving, operating and monitoring activities and for work with a risk of falling.

LEGAL BASIS

Ordinance on Preventive Occupational Health Care Sections 2, 3, 4, 5 and Annex

FURTHER INFORMATION

- DGUV Information 250-010 "Fitness testing in operational practice"
- Occupational medicine recommendation "Elective preventive care" of the BMAS

1.3 Evaluation of the work conditions

The evaluation of the work conditions "Hazard assessment guide" (Gefährdungsbeurteilung) is the central element in health and safety. Hazard exposures for employees are systematically ascertained. The associated risks are evaluated and the required protective measures are derived. By verifying the effectiveness of protective measures that are implemented, the hazard assessment enables and supports a continuous improvement process (see Figure 2 "Hazard assessment flow chart"). This section summarises the essential contents of a hazard assessment. For a detailed description and instructions, see the "Hazard assessment guide".

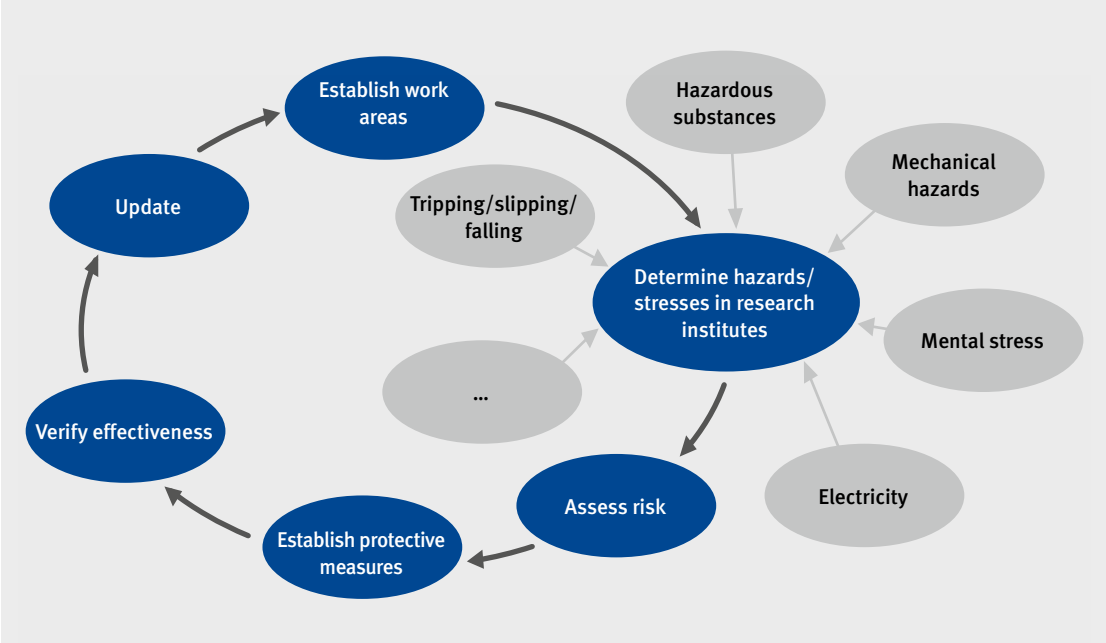


Figure 2: Hazard assessment flow chart

FURTHER INFORMATION

"Hazard assessment guide"

1.3.1 Hazard assessment

The hazard assessment is a method
- for the systematic, preventive determination of hazards,
- their evaluation,
- establishing appropriate protective measures, and
- verifying their effectiveness.

It also supports the optimisation of workflows and helps prevent disruptions in operating processes.

1.3.2 Reasons for the hazard assessment

In principle, a hazard assessment has to be carried out for every workplace before the start of work. Hazard assessments have to be reviewed regularly and updated as needed. Also note the requirements for review and update intervals according to the applicable legal framework. For example, the Ordinance on Safety and Health Protection at Workplaces Involving Biological Agents (Biological Agents Ordinance, Biostoffverordnung (BioStoffV)) requires a review at least once every two years. Existing hazard assessments also have to be updated on the following occasions in particular:
- Use of new working materials
- Changes to work equipment and machinery
- Changes to work areas and traffic routes
- Changes to work processes and activities
- Changes to the work organisation
- Occurrence of accidents, work-related illnesses and occupational diseases
- Occurrence of burdens and complaints
- Regulatory changes

LEGAL BASIS
Biological Agents Ordinance

1.3.3 Criteria for a hazard assessment

Which criteria do an appropriate hazard assessment have to meet?
- A hazard assessment has to be carried out correctly and cover the material aspects. What that means:
  - Significant hazards are determined and correctly evaluated
  - Significant workplaces and activities are evaluated
  - Special groups of persons are considered – for example, inexperienced workers or staff without adequate knowledge of the working language
  - Groups of employees requiring special protection are considered, for example, minors, pregnant women and nursing mothers, and people with disabilities
- Health and safety measures are appropriate and adequate
- The effectiveness of the measures is verified
- The hazard assessment is current
- Documentation, appropriate in form and content, is on hand

1.3.4 Minimum contents of a hazard assessment

In principle, the following must be observed:
- The general work environment at the institute
- Activities that generally have to be completed at the institute (including administration, technical service, cleaning, maintenance of the grounds) and the organisation of workflows and collaboration
- Unusual hazard situations in specific research projects (for example, unknown properties of sample materials and reaction products)
- Significant hazards for personnel working outside the institute premises – for example, during conventions, trade fairs or research trips
- Maintenance, upkeep, troubleshooting and setup of infrastructure and equipment

Make sure that the workplaces, research sites and laboratories are suitable for carrying out the planned research projects. This also applies for projects conducted outdoors, for example. Therefore, conduct a preliminary check for possible hazards or deficient infrastructure. Evaluate the following among other things:

- Dimensions of rooms
- Location, condition and identification of traffic routes, escape routes, emergency exits, assembly points and the identification of hazard areas
- Presence and identification of technical fire protection equipment and first aid facilities
- Availability and suitability of storage, engineering and secondary rooms, sanitary facilities (change rooms, washrooms and toilets), break and duty rooms, and vehicle parking spaces
- Technical equipment and machinery, furnishings, other work equipment, lighting, ventilation, heating and utilities, announcement and alerting systems, electricity supply
- Construction and stability of the physical structure, carrying capacity of the traffic routes
- Structural facilities against falling from heights and falling objects

Unusual hazard situations in specific research projects that are not considered in the basic hazard assessments have to be evaluated in a special hazard assessment. Note that the hazard assessment has to be taken into account starting in the project planning stage (for example, when the project application is first submitted). This ensures, for instance, that sufficient funds for required protective equipment are budgeted in the project application. The hazard assessment has to be continuously reviewed in the course of the project and updated as needed. In particular, this needs to happen before actually starting the project (after planning is completed and funds are obtained), when changes are made to the test setups and/or approach, and after (near) accidents. The required time and financial resources for this have to be included in planning. Obtain corresponding advice from specialists as warranted – for example, the company doctor, health and safety officer and experts.

Also determine the significant hazards for personnel working outside the institute premises – for example, during conventions, trade fairs or research trips. Foreseeing all concrete hazards that may occur on site is not always possible. Unexpected hazards may occur due to the complexity of the work situations and work environments in research. Suitable staff with sufficient qualifications for the activities and the ability to make appropriate decisions according to the situation must therefore be deployed. The hazard assessment assists an experienced specialist (such as the project manager) with management and supervision. Before the start of research projects at external institutes (measurement periods, for example), check the local conditions and ask those responsible at the external institute for support with your hazard assessment.

Practical examples of implementing the protection goals are described, among other things, in the information bulletins of statutory accident insurance providers. They represent approaches and working methods that have been proven over many years. When the requirements according to industry information sources are met, one can generally assume that the residual risk has been adequately minimised. Findings from the industry information sources have, for example, been taken into account in the electronic hazard assessment tool (VBG-Software zur Gefährdungsbeurteilung (GEDOKU)). For detailed information on designing the infrastructure in research institutes, typical hazards and examples of protective measures, see Chapter 3.

FURTHER INFORMATION

GEDOKU

Chapter 3 Technical information

1.3.5 Documentation of the hazard assessment

The ArbSchG obliges employers to keep documentation on file documenting the result of the hazard assessment. This documentation is used to manage the hazard assessment process. It serves as proof that the legal obligations were met appropriately. The following should be documented as a minimum:

- Evaluation of the hazards for the work areas and activities under consideration. Systematic determination and evaluation of the hazards must be evident. Information about the result of the risk assessment has to be included, for example: Assessment of risk or action required? YES/NO
- Establishment of concrete health and safety measures, including due dates and persons responsible
- Implementation of the measures and verification of effectiveness (evaluation of the residual risk)
- Date of creation/update

The documentation may have a modular structure. Special documentation requirements in health and safety regulations must be observed. For example, see the Hazardous Substance Ordinance (Gefahrstoffverordnung, GefStoffV) or the Maternity Protection Act (Mutterschutzgesetz, MuSchG).

1.3.6 Verification of effectiveness

Careful verification of effectiveness is required for the necessary health and safety measures. This applies in particular for research projects with complex processes and hazards.

- Prospective: Carrying out and documenting the evaluation of the risk in two steps is recommended. Your assessment as the person responsible is based on whether, in your experience, the residual risk can be sufficiently minimised with the proposed measures
  a) Evaluation of the initial situation without consideration of the corresponding health and safety measures
  b) Re-evaluation of the situation under consideration of the health and safety measures required for risk minimisation
- Ongoing: By you as the responsible person. Examples include regular reviews of technical protective measures, observation, and communication with employees about the use and suitability of personal protective equipment (PPE)
- Retrospective: After incidents, based on new experiences and findings, based on abnormalities in the course of preventive occupational medicine; to realise a continuous improvement process
- Special methods for the verification of effectiveness exist for special hazards, such as the handling of certain dangerous substances. These are generally described in the respective technical rules (for example, BAuA – Legislative Texts and Technical Rules – Technical Rules for Hazardous Substances (TRGS) and must be observed unless a solution that is at least as safe is found. For instance, measurements of the dangerous substance concentration in the ambient air at the workplace can be taken for the verification of effectiveness in case of substances with inhalation hazards. Biomonitoring can be used for the verification of effectiveness in case of dangerous substances that accumulate in the body through inhalation or skin absorption.

LEGAL BASIS

- Measures of occupational safety and health Sections 5, 6
- Maternity Protection Act
- Hazardous Substance Ordinance
- TRGS
- DGUV Regulation 1 Section 3 "Principles of Prevention"

1.4 Instruction and directives

The objective of instruction is to obtain or maintain safe and healthy behaviours. Employees need to know what hazards are associated with their work and what protective measures have been implemented against them. To this end, the evaluation of work conditions and instruction are linked in operational practice. Directives have to be prepared for the safe use of work equipment and dangerous substances, taking the results of the hazard assessment into account. These directives serve as the basis for instruction.

Tell the persons receiving instruction – employees, students or guest researchers – about the safe operation of technical facilities. Discuss the objectives of organisational measures. Explain the correct use of the required personal protective equipment (PPE). Where applicable, practice the use of hearing protection and PPE against falling from heights. Encourage the staff instructed by you to comply with or implement safety measures and to make suggestions for improvements.

FURTHER INFORMATION
Chapter 3.2.1 Work equipment and technical facilities

1.4.1 Reasons for and types of instruction

Perform instruction regularly to the appropriate extent.

When is instruction required?

- Before the start of the activity or new tasks
- In case of changes within spheres of activity
- After setting up or making changes to a place of work
- When introducing new work equipment, working materials or methods (for example, new test setups)
- After accidents
- In case of activities at other locations (for example, test setups outdoors, in external laboratories or the like). This instruction accounts for additional hazards that could arise due to the environment and the technology and processes being used

Perform the general instruction at least annually, the supplementary instruction before and where applicable also several times before and during a research project.

Institute management can also make direct operational supervisors responsible for instruction or assign another, personally and functionally qualified person to help with instruction.

Instruction must be carried out in a comprehensible form and language (for example, the foreign language used in the research project) , see VBG-Praxis-Kompakt “Instruction and communication in practice” (Praxis Unterweisung und Kommunikation). Instruction is done verbally as a rule. Not all employees at the research institute may be able to attend. Computer-aided instruction is appropriate in this case. Instruction programs must meet the following requirements as a minimum:

- The content has to be prepared for the specific place of work
- Comprehension has to be verified
- Discussion between the employees and managers must possible in addition at any time

1.4.2 Documentation of the instruction

You can use a form to document the instruction provided. Record the instruction contents and date in the “proof of instruction”. Sign the proof of instruction, have it signed by the persons instructed and retain it as documentation.

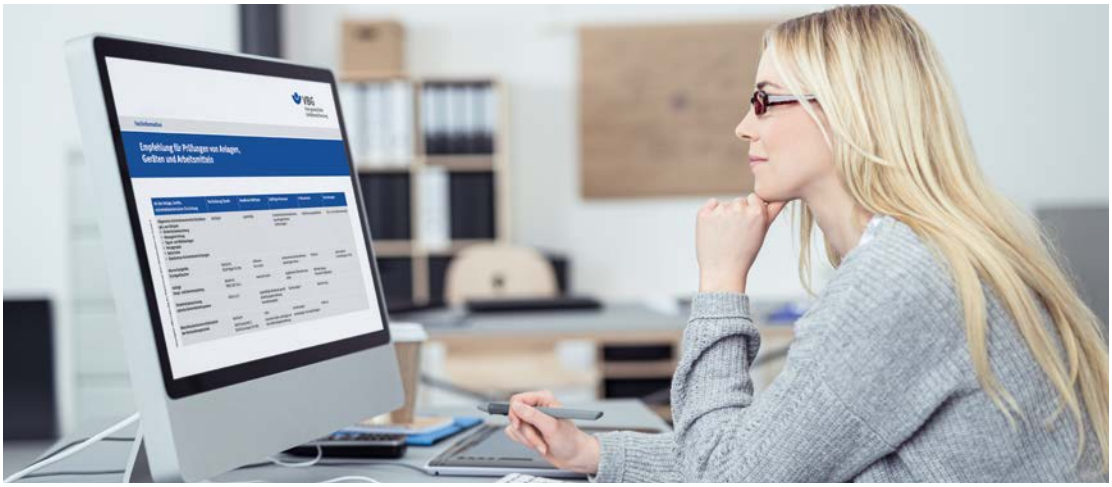
LEGAL BASIS

- Measures of occupational safety and health Section 12
- DGUV Regulation 1 Section 4 “Principles of Prevention”
- Sample directive (Musterbetriebsanweisungen)

FURTHER INFORMATION

- DGUV Information 211-010 “Safety through directives”
- DGUV Information 250-010 “Fitness testing in operational practice” (“Eignungsuntersuchungen in der betrieblichen Praxis”)
- VBG-Praxis-Kompakt “Instruction and communication in practice”
- Instruction

1.5 Work equipment and working materials



Establishing safe work conditions includes providing safe work equipment and the safety-conscious use of working materials. Work equipment includes tools, equipment, machinery or plants. Plants are comprised of multiple functional units that interact with each other. Their safe operation is substantially determined by these interactions. Working materials are all chemical and biological substances, mixtures and products that are used, produced, processed, created or released during work. PPE that may be required has to be considered in the procurement of work equipment and working materials.

Selection of work equipment and working materials

Base the selection of work equipment and working materials on the planned use, experience of the personnel and expected hazards. For work equipment and working materials with special hazards, review to what extent they can be substituted by non-hazardous or less hazardous work equipment and working materials.

Procurement of work equipment and working materials

Only procure flawless and labelled work equipment – for example, with the GS marking. Where possible, only procure working materials that, according to the result of the hazard assessment, do not impair the health of personnel. To keep hazards for personnel as low as possible, the minimisation principle applies for the procurement and use of dangerous substances.

Acceptance of work equipment and working materials

The requirements for the acceptance of work equipment and working materials are the same as for procurement. Check whether the work equipment corresponds to the specifications and requirements defined by you. Also check all assured functions, features and characteristics. For machinery and equipment with special protective devices, check that these are in safe condition after delivery.

Make sure that only authorised personnel with special training has access, for example, to keys for the deactivation of protective devices for maintenance and repairs, and that these do not remain on the equipment after setup.

The principle of checking for substitutes and the minimisation principle apply for the acceptance of dangerous substances.

Documentation for work equipment and working materials

Make sure that the required documentation is on hand. This includes, for example:

- Assembly and operating instructions
- Operating manual
- Directives
- Safety data sheets
- Inspection and testing instructions and criteria
- Inspection and testing documentation, certificates and reports
- Declarations of conformity

LEGAL BASIS

- Measures of occupational safety and health Sections 3, 4
- Industrial Safety Directive Section 4

Use of work equipment and working materials

Plan all measures required for the health and safety compliant use of work equipment and working materials.
Example:

- Directives and instructions
- Use of protective devices
- Use of personal protective equipment
- Maintenance, service and repair
- Official inspections

FURTHER INFORMATION

Chapter 2.2.4 Coordination
Chapter 2.4 Communication and documentation

Inspection, maintenance and repair of work equipment

Make sure that the facilities, work equipment and PPE are inspected and maintained by competent persons at the required intervals. Intervals and competent persons are determined and established in the evaluation of work conditions.

FURTHER INFORMATION

VBG Technical bulletin "Recommendations for the Inspection of Facilities, machines and work equipment"

1.6 Emergency organisation, fire protection and first aid

Various incidents such as a fire, discharge of dangerous substances, a person running amok and the like can trigger an alarm and evacuation of a research institute. Everyone concerned then has to be evacuated from the danger area safely and quickly. Well organised first aid is also essential in case of accidents and emergencies.

1.6.1 Emergency organisation

The object of an emergency organisation is to implement the emergency strategy based on the institute-specific protection needs and the corresponding risk analysis. You should be prepared if something does happen. That is the purpose of an effective emergency organisation. The emergency organisation is comprised of incident preparedness and incident response. Your employees know what to do in case of an emergency in order to minimise secondary damage. Nobody panics because everyone knows what has to be done. Managers respond judiciously and make clear decisions.

Examples of typical emergencies are:
- Accident, serious illness
- Fire
- Gas alarm
- Explosion
- Bomb threat

You need to take day-to-day operations into account as well as special events, such as an open house or project meeting.

Conduct and document emergency exercises regularly with your staff.

FURTHER INFORMATION

DGUV Information 205-033 “Alerting and evacuation”

1.6.2 Fire protection

Fires can occur – not only in research institutes working with combustible materials or doing work with potential fire hazards. A fire can also develop in administrative areas, for example, because of defective electrical equipment. How can you prevent fires and what should you do in case of fire? See Technical Rules for Workplaces (Technische Regeln für Arbeitsstätten (Arbeitsstättenregeln – ASR)).

LEGAL BASIS

- Measures of occupational safety and health Section 10
- Workplace Ordinance Section 6
- DGUV Regulation 1 Sections 21, 24–28 "Principles of Prevention"
- DGUV Rule 100-001 "Principles of Prevention"

FURTHER INFORMATION

- ASR A1.3 "Safety and health protection labelling"
- ASR A2.2 "Measures against fires"
- ASR A2.3 "Escape routes and emergency exits"
- DGUV Information 205-001 "Operational fire protection in practice"

FURTHER INFORMATION

- DGUV Information 205-003 "Tasks, qualification, training and appointment of fire protection officers"
- DGUV Information 205-023 "Fire protection helpers – training and qualification"
- DGUV Information205-026 "Safety and health protection for the use of fire extinguishing systems with quenching gases"
- DGUV Information 205-033 "Alerting and evacuation"
- DGUV Information 205-034 "Use of carbon dioxide (CO_2) – fire extinguishers in rooms"
- DGUV Fachbereich aktuell "Selection and use of fire extinguishers in fire fighting exercises"

Fire protection concept and alarm plan

Check whether a current fire protection concept and an alarm plan for evacuation are on hand for your institute.

Clarify whether the organisational fire protection measures correspond to the statutory requirements and/or organise the required measures. In case of special fire hazards, get advice from a specialist planner for fire protection or the responsible fire protection office as needed.

Fire protection notices

Make sure that the notices required for your company exist and are posted in strategically meaningful locations.

Check whether the prohibition "No open flames, fire, open ignition sources or smoking" is posted in readily visible locations. Deviating from this prohibition is only permitted if special fire protection measures are implemented.

Fire protection and evacuation helpers

To ensure that incipient fires are put out as quickly as possible before they grow, part of the regular staff has to be familiarised with the use of fire extinguishing equipment through instruction and exercises. Depending on your hazard assessment, train at least ten percent of the employees on site as fire protection and evacuation helpers and make them known to your staff. Conduct regular evacuation exercises with your staff. Instruct personnel in the use of existing fire extinguishing equipment and document this instruction. Note the special requirements for the use of CO_2 fire extinguishers and automatic fire extinguishing systems.

Escape and rescue routes

Make sure that the escape and rescue route plans required for your research institute are prepared, updated in case of changes and posted at strategically meaningful locations. Make sure that the full width of the escape and rescue routes is accessible at all times and not blocked, and that the emergency exits can be opened easily.

Fire extinguishers

Make sure that the fire extinguishing equipment required for your institute – according to the established fire hazards – is on hand, inspected regularly and that the locations of this equipment are marked.

Information

Inform staff of the necessary fire protection and evacuation measures. Show the course of the escape and rescue routes and the locations of assembly points. Familiarise your staff with the locations of the fire extinguishers.

1.6.3 First aid

First aid consists of medical, organisational and patient care measures for people who are ill or injured, using simple means. It includes calling emergency services.

Facilities and resources

Provide the first aid resources required for your research institute, such as first aid materials and signalling equipment. Make sure that the existing first aid resources are readily accessible at all times and replenished/replaced in a timely manner. Make sure that the first aid notices required for your company are prepared and posted at strategic locations.

First-aid attendants

Train a sufficient number of your personnel as first-aid attendants – at least ten per cent of the staff on site. When the number of staff regularly on site is less than 20, make sure that at least one first-aid attendant is present. Employee absences due to business trips, part-time work, holidays or illness also have to be considered here.

Information

Inform the staff about the first aid facilities and required measures in case of emergency in coordination with the company doctor.

First aid documentation

Make sure that all first aid services are documented and that this documentation is retained for at least five years – for example, in electronic form or paper form as a tear-off pad. Treat the documents as confidential. Point out the need for documentation in the course of instruction.

LEGAL BASIS

- Measures of occupational safety and health Section 10
- Workplace Ordinance Section 6
- DGUV Regulation 1 Sections 21, 24–28 "Principles of Prevention"
- DGUV Rule 100-001 "Principles of Prevention"

FURTHER INFORMATION

- ASR A2.3 "Escape routes and emergency exits"
- ASR A4.3 "First aid rooms, resources and facilities"
- DGUV Information 204-001 "Poster – first aid"
- DGUV Information 204-006 "First aid instruction"
- DGUV Information 204-007 "First aid manual"
- DGUV Information 204-021 "Documentation of first aid services (memo pad)"
- DGUV Information 204-022 "First aid in the operation"

1.6.4 Safety measures for special events

The fire protection and first aid measures described above are also valid on days with special events. Examples include an open house or project meeting. Additional measures have to be implemented depending on the type and size of the event.

Safety concept

A safety concept has to be prepared when warranted by the type or size of the event. In addition to visitor safety, this is in the interest of staff safety.

Examples of criteria for the preparation of a safety concept:
- Regulatory requirements (selection of the venue, number of visitors, size of the venue)
- Type of event
- Venue – for example, when a site was not originally intended as a place of assembly or for complex sites
- Interaction with visitors in laboratory areas

When participating in an external event, obtain information about the organiser's safety concept as early as possible and inform them about your own safety requirements.

Also inform the personnel of the measures in the safety concept for the event.

Security

Check whether security staff is required for the type of event.

Provisions for people with disabilities

Make arrangements for informing and evacuating people with disabilities in case of danger. Examples include appropriate communication equipment, evacuation aids and training for designated attendants.

Fire protection concept and alarm plan

Check whether the fire protection measures required for your event have been implemented. In case of events with elevated fire hazards, get advice on compensation measures from a specialist planner for fire protection or the responsible fire protection office.

Fire safety guard

Where applicable, appoint the number of fire safety guards according to the hazard assessment or the compensation measures established with the fire protection office.

Fire extinguishing equipment

Ensure that the necessary, inspected fire extinguishing equipment is on hand during the entire event. Equipment locations have to be marked. This also applies for setting up and taking down test setups.

Escape and rescue routes

Leading up to your event, check the maximum permitted number of persons for the existing premises, including escape and rescue routes. Prepare additional escape and rescue plans where applicable. Post them at strategic locations. Make sure that the full width of the escape and rescue routes is accessible at all times during the event. Take steps to ensure that emergency exits are easy to open and not blocked.

Information

In case of changes compared to everyday institute operations, instruct your personnel in the necessary, additional fire protection and evacuation measures. Show your staff the course of the escape and rescue routes and locations of assembly points. Familiarise your staff with the locations of the additional fire extinguishing equipment.

First aid

Leading up to the event, check whether sufficient first aid materials are on hand and organise the reporting of emergencies. Make sure that first aid notices as required for your event are prepared and posted at strategic locations. Organise your teams so that sufficient first-aid attendants are available at strategic locations. Check whether a medical service is required for your planned event.

1.7 Documentation

As described in the previous sections, certain points have to be documented regarding occupational health and safety. On the one hand, this documentation is used internally for traceability and to verify the realisation of health and safety obligations. On the other hand, it is used for a seamless transition in the course of staff changes that frequently occur in research institutes. For institute management, the documentation also serves as proof for government authorities (state health and safety authority, public prosecutor's office) and the accident insurance provider's inspectorate. It shows that you met your health and safety obligations, and how. This documentation includes the following documents among others:

- Transfer of obligations
- Result of the hazard assessments, implementation of measures and verification of effectiveness
- Directives, work instructions and safety data sheets
- Proof of instruction
- Inspection and maintenance records
- Fire protection regulation
- Acceptance records for the transfer of facilities and services
- Agreements and reports regarding safety and the services of a company doctor
- Proof of preventive occupational medical care
- Measurement reports (for example, for dangerous substance or noise measurements)
- Register of dangerous substances
- Exposure register for activities with carcinogenic or mutagenic dangerous substances
- Explosion protection document (if required)
- Documentation of first aid services
- Laboratory procedures and plans
- Time sheets
- Etc.

Note the different requirements for retention periods depending on the document. The documentation for first aid measures, for example, has to be retained for 5 years. The exposure register for activities with carcinogenic or mutagenic dangerous substances has to be retained for at least 40 years after the exposure ends.

2 Organisation of research projects

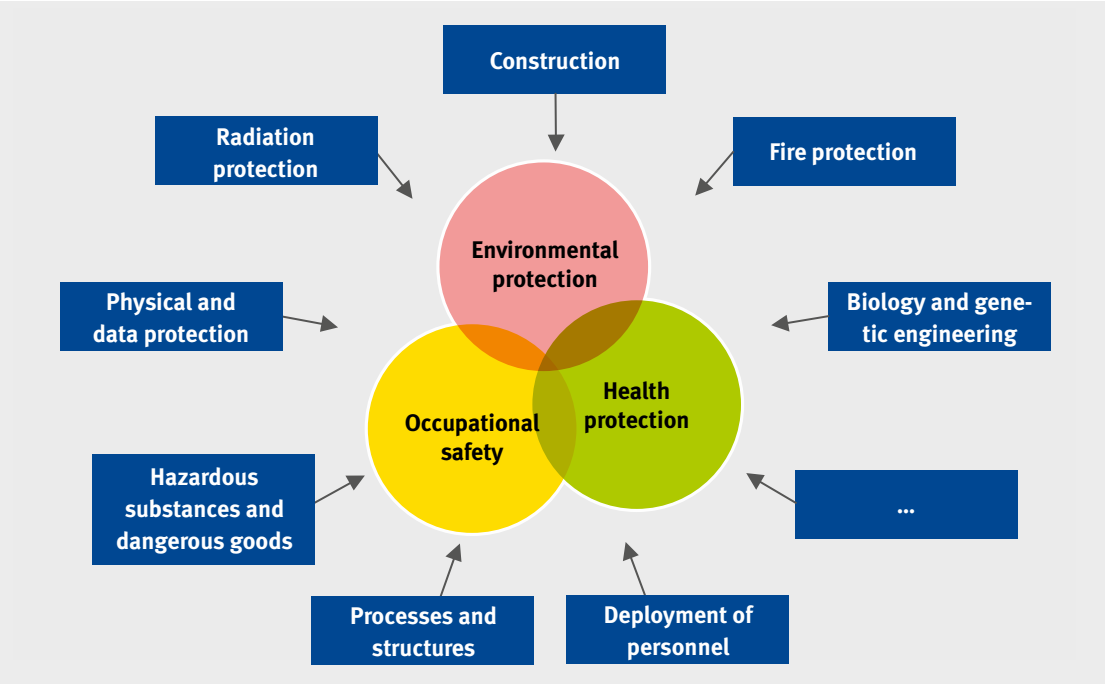


Figure 3: Health and safety in research projects

This section examines the planning and organisation of health and safety in research projects. Specific steps that have to be considered for this in a research project are presented. Examples include evaluating the work conditions, the requirements for employees, safe work equipment and the work environment. Thus this section is intended for people assuming organisational and functional responsibility for conducting research projects, for example, in project management, research group management and laboratory management.

Ensuring that health and safety are maintained in the course of successfully conducting a research project is a demanding task. Aspects that have to be considered may vary depending on the type of research project. For purely internal research, the institute can plan the project entirely on its own and, for example, adapt the infrastructure, project contents and qualifications of the employees to each other. In bilateral projects, the requirements of the respective project partners and communication between them also have to be taken into account. For larger, publicly funded research projects with project partners from various fields (interdisciplinary projects), not only the project application but also the planning of health and safety at the touch points is correspondingly complex. This is particularly true for international interdisciplinary projects with intensive exchanges between the participating scientists. The same vocabulary sometimes has slightly different meanings between disciplines, leading to possible misunderstandings. Health and safety may be differently organised at each institute and different rules apply internationally. Corresponding coordination is required to avoid misunderstandings.

Occupational health and safety should therefore be considered starting in the project planning phase or the project application, but at the latest once the project is approved. Different and often competing requirements demand a high level of experience to adequately evaluate the circumstances. For an overview of some areas to consider, see Figure 3 “Health and safety in research projects”. In particular, prevention in the following areas also leads to a more effective use of resources:

- **Deployment of personnel:** Have all aspects been considered that help employees maintain their health, and to work safely and with motivation according to their abilities?

- **Occupational safety:** Is compliance with all requirements and laws assured with regard to the nature of workplaces, machinery, product safety and dangerous substances?
- **Health protection:** Has health protection been taken into account in addition to occupational safety? Is the setup of workplaces ergonomic? Have measures to reduce mental stress been implemented?
- **Construction:** Are there structural requirements that have to be considered (for example, fire and explosion protection, dangerous substance storage, width of traffic routes depending on the number of persons)? Are building sections being used differently than before, and are structural adaptations required here?
- **Biology and genetic engineering:** What biological/pathogenic working materials are used, including genetically modified organisms? Are the corresponding technical rules being followed? Are activities subject to official permits or reporting obligations planned?
- **Fire protection:** Are additional fire protection precautions required for the project? Is spontaneous combustion possible if materials being used come into contact with oxygen? Is the existing equipment, such as fire extinguishers, suitable for the combustible materials and the quantities being used? Are the reporting chains adequate? Has the fire brigade been informed about the situation on site and any existing hazards? Are the fire protection helpers sufficiently familiar with the (new) fire protection precautions?
- **Hazardous substances and dangerous goods:** Are new dangerous substances being used for the project, or are larger quantities of already used substances needed? If so, are the existing storage, (internal) transportation and fire protection, for example, still adequate or do changes have to be made (such as an additional hazardous substance cabinet)? Have arrangements been made for the handling of sample materials with unknown properties? Are special containers required, for example, to exchange sample materials between project partners?
- **Physical and data protection including confidentiality:** Are stricter access restrictions required for the project? Are there special requirements, for example, for IT because of sensitive data (systems not connected to the Internet, for instance)?
- **Radiation protection including NIR:** Are all radiation protection requirements including near infrared (NIR) being observed? Are areas clearly defined? Do access restrictions have to be established (for example, for special groups of people)?
- **Environmental protection:** Is environmental protection adequately taken into account? Aside from soil, air and water protection, this includes, for example, emission protection, animal welfare, nature conservation, recycling, waste and energy.

The responsible persons must have appropriate authority to act and make decisions for the implementation of any required measures.
The key aspects for health and safety that must be considered for legal certainty during project planning are presented as a flow chart in Figure 4 “Reliable organisation of research projects” . Individual aspects are covered in subsequent sections listed in the figure.

Further details regarding equipment and the necessary precautions in various facilities such as laboratories are described in Chapter 3, including references to further technical information. A review and verification of effectiveness is recommended after every research project. This helps to avoid mistakes, better assess risks and further optimise the process in future planning.

FURTHER INFORMATION

Chapter 3 Technical information

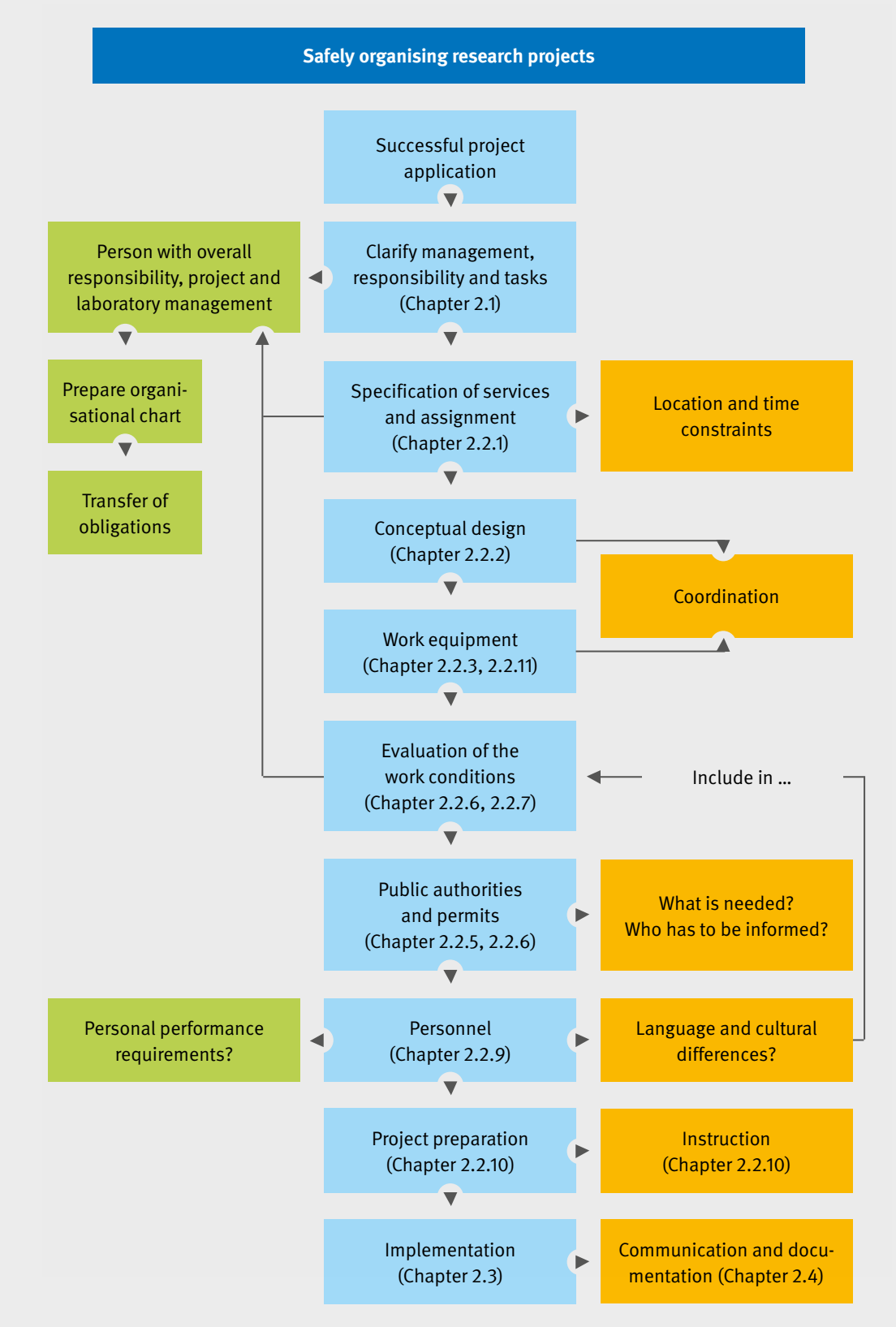


Figure 4: Reliable organisation of research projects

2.1 Management and responsibility in research projects

To ensure health and safety in research projects, it is important for institute management to appoint a person in writing with overall responsibility for the research project. Tasks and responsibilities have to be clearly defined. Depending on the organisational structure, the tasks and areas of responsibility may also be shared among those taking part in the project. Responsibilities for health and safety have to be specifically assigned in accordance with the respective tasks.

FURTHER INFORMATION
Chapter 1.1 Management and responsibility in the research institute
Chapter 1.2 Personnel

Clarify the functions, tasks and authority to issue directives of all research project participants – from project, research group or laboratory management to research assistants, doctoral candidates and students to technical support services, where applicable, and external service providers – and establish these with regard to health and safety.

The person with overall responsibility is a reliable, competent person who manages and supervises the research project. As a rule, the research group, project or laboratory manager serves as the person with overall responsibility. Management and supervision of the work means independently assuming management and functional responsibilities on site.This includes establishing and implementing the protective measures required for the respective activity and verifying their effectiveness.

If equipment, facilities or test setups are built in-house, certain manufacturer obligations have to be met depending on their type and use. This also applies for equipment, facilities and test setups built solely for internal use. Perform a diligent review of what obligations you have to meet and under what circumstances the equipment, facility or test setup may be operated for research purposes.

FURTHER INFORMATION
Chapter 3.2.1 Work equipment and technical facilities

Laboratory managers monitor the execution of all work that takes place in the respective laboratory. They have the authority to issue directives within their functional area of responsibility, and are responsible for health and safety in their laboratory.

Users (i.e. project employees) of test setups have to monitor the safe condition of their workplaces, operating equipment and the work equipment provided, and report defects. The work equipment must be used as intended and the instructions of responsible persons have to be followed.

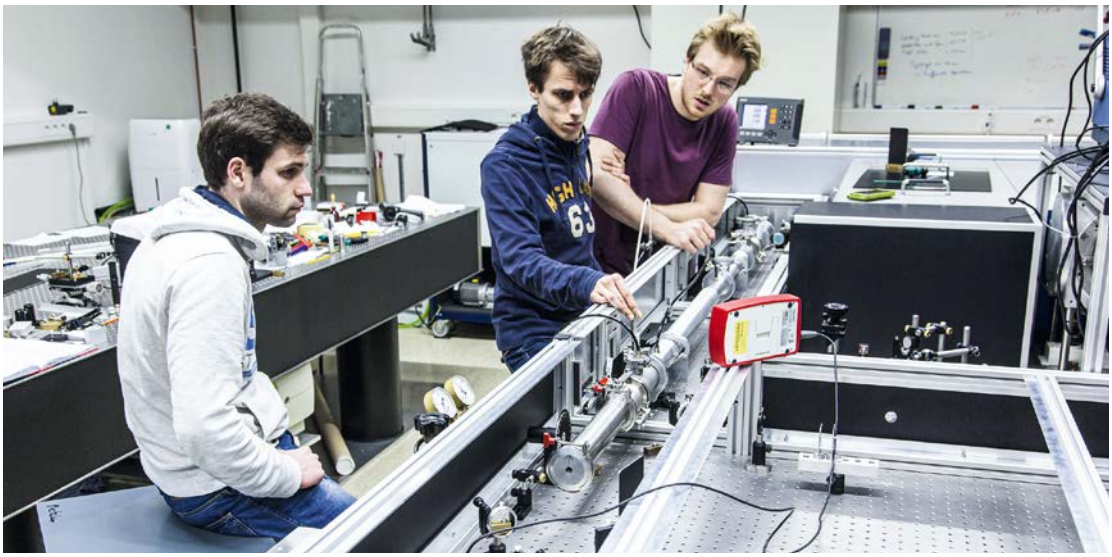
Mutual hazards may arise when two or more companies work together (including external service providers such as electricians, mechanical engineers or the like). It is important to appoint a reliable, competent person as a coordinator in such cases to coordinate the work. The coordinator must be given corresponding authority to issue directives in order to avert specific hazards.

Preparing an organisational chart helps with the transparent illustration and communication of responsibilities for your research project.

With a sample transfer of obligations, you establish who assumes responsibility for what tasks in the interest of health and safety in the research project. This may be part of the employment contract or take the form of an additional agreement.

FURTHER INFORMATION
Sample transfer of obligations

2.2 Planning of experiments, test setups and research stays



Since resources are limited and due to the open-ended nature of research projects depending on the form of cooperation, planning is also of special importance with regard to occupational health and safety.

2.2.1 Specification of services and assignment

For projects with multiple project partners or the involvement of external service providers, the research institute has to clearly and comprehensively describe the services to be provided, according to the form of cooperation, prior to assignment and the conclusion of contracts.

The written specification of services can include the following, depending on the type of research project:

- Organisational and scheduling framework
- Local conditions
- Required work equipment, facilities
- Personal protective equipment and its provision and use
- Special requirements for the operational safety of work equipment and facilities
- Required material properties
- Fire protection, weather resistance and transportability, also of safety devices such as housings and shields
- Special skills and technical qualifications of personnel where applicable
- Coordination requirements, coordination of services with other participants

- Duty to provide information about hazards associated with delivered services and products
- Required documentation – for example, structural analysis, instructions for installation, conversion and removal, material certifications

Much of this is already included in the project application, while other things need to be added.

2.2.2 Conceptual design

Get the research project participants involved in organisation and take the following aspects into account, starting in the project planning phase:

- easibility and practical implementation of the research project
- General conditions that influence the implementation of the research project and may endanger the participants
- Reviewing the suitability of the laboratories, technical centre facilities and basic infrastructure (especially the required media such as high-voltage current, compressed air, gases etc.)
- Incidents to be expected and possible behaviour of the participants

The latter applies in particular when less experienced people are taking part in the project, such as interns, students or doctoral candidates beginning their thesis. Also consider that external personnel such as guest scientists are not yet familiar with the local conditions, and that occupational safety and health at their home institute may be organised and practised differently. A detailed introduction and familiarisation period for these groups until processes function smoothly must be incorporated in planning. Mentoring systems have proven themselves here in practice. However, this requires the mentors to have occupational safety and health knowledge in addition to technical expertise and the corresponding authority to issue directives.

2.2.3 Preliminary inspection: Work environment, work equipment and working materials

Whether the facilities and technical building equipment are adequate for the research project needs to be reviewed during planning. If not, either the project or the facilities and technical conditions must be adapted accordingly.

- Perform a preliminary inspection of the laboratories to clarify the practical implementation – for example, equipment, operating areas, entrances, traffic and escape routes, fire protection – and the conditions for the test procedure.
- Include corresponding specialist personnel in the preliminary inspection. The laboratory manager, health and safety officer, hazardous substances officer, fire protection officer, laser protection officer etc. may be involved.
- Make sure that adequate, ergonomic workstations are available for the planned personnel and, for example, that the required traffic route widths and clearances continue to be maintained with possible additional staffing.

Clarify whether new work equipment, test setups or safety devices are needed for the project. If so, prepare a hazard assessment for the work equipment and facilities prior to procurement. Purchasing reliably planned facilities and components can avoid the time-consuming and costly retrofitting of safety-related elements. If equipment, facilities or test setups are built in-house, certain manufacturer obligations have to be met depending on their type and use. This also applies for equipment, facilities and test setups built solely for internal use. Therefore, perform a diligent review of what obligations you have to meet and under what circumstances the equipment, facility or test setup may be operated for research purposes. Information on the reliable design of the work environment is also found in Chapter 3. Document all relevant details of the preliminary inspection.

FURTHER INFORMATION
Chapter 3 Technical information

2.2.4 Coordination

Inform the responsible health and safety officer of the planned research project. If problems relevant for safety become evident in the course of planning and execution, get the health and safety officer involved. Establish a coordination process between the researchers, technicians and the health and safety officer. To minimise specific hazards associated with setups and experiments, ensure close coordination between the health and safety officer, company doctor and other health and safety experts such as the hazardous substances officer, laser protection officer and others.

2.2.5 Public authorities and permits

Get the responsible authorities such as the state labour protection office or radiation protection involved as needed.

Note that permits have to be obtained with the required lead time – for example, when approval is needed for a change in the use of rooms, buildings or facilities. Certain substances also require approval (for example, radioactive substances, genetically modified organisms, the handling of pathogens according to the Infection Protection Act (Infektionsschutzgesetz (IfSG)). A corresponding permit for their use has to be requested from the authorities. Inform the participants of the permits and the requirements they contain, and make sure they are met.

LEGAL BASIS
Infection Protection Act

2.2.6 Hazard assessment

Hazards arising from the research project must be taken into account ahead of time in the hazard assessment (evaluation of work conditions). This includes, for example, incidents that are difficult to assess because of the environment, sample materials, people and technology.

Also take the individual (performance) requirements of the project participants into account. Aside from technical experience, this includes knowledge of the applicable health and safety provisions. Here the technical, language and cultural background of the employees must be taken into account. The same technical terms may be interpreted somewhat differently in various disciplines (for example, the terms test, run, scenario). A shared, prescribed terminology is required here, especially for interdisciplinary research.

FURTHER INFORMATION
Chapter 1.3 Evaluation of the work conditions

2.2.7 Specific hazards

In the hazard assessment (Chapter 2.2.6), ascertain the necessary measures to successfully mitigate special hazards resulting from the research project. Specific hazards can in particular arise from the sample materials, test setups or the facilities and media being used. If the ingredients of sample materials are unknown, hazards may arise from the sample as such but also from unexpected reactions of the material. Depending on the test setup and the facilities and media being used, hazards may arise, for example, due to the discharge of media, pressure, noise, vibrations, overheating, fire, explosion, deflagration or radiation. Define corresponding measures for all possible hazards to avoid accidents and protect the health of personnel.

FURTHER INFORMATION
Chapter 3 Technical information

2.2.8 Traffic and escape routes, emergency exits

Establish the traffic and escape routes for the workplaces depending on the number of people on site.

FURTHER INFORMATION

Chapter 1.6 Emergency organisation, fire protection and first aid
Chapter 3.1.1 Traffic zones in buildings

2.2.9 Personnel

Personnel includes the people involved in the research project, regardless of their status or concrete employment relationship. Examples are permanent staff, project employees including guest scientists, student trainees, doctoral candidates and students writing their diploma thesis.

Requirements for personnel

Make sure that the deployed personnel have appropriate qualifications and experience for the respective work task. Some aspects that should be considered in the selection of personnel for research projects are described below.

- The required skills (qualifications and experience) are determined based on the complexity and scope of the research project. For example, postdocs, doctoral candidates or students can be employed to conduct tests, depending on the sub-question or sub-task. When tests will be carried out by inexperienced personnel, sufficient training, close supervision and support must be provided.
- Contractors have to employ personnel with appropriate qualifications for all activities within the contractually agreed scope of work. The personnel must be fluent in the project language, spoken and written.
- When persons without specific qualifications are involved – for example, university or school students, or a broader public during an open house – the persons responsible have a special duty of care.
- Guest scientists are subject to Germany's labour protection laws and obliged to comply with them.
- Whether compulsory preventive occupational medical care is necessary because of special climate stresses and infection hazards has to be reviewed for research stays abroad, see Ordinance on Preventive Occupational Health Care (Verordnung zur arbeitsmedizinischen Vorsorge (ArbMedVV)).

FURTHER INFORMATION

- Ordinance on Preventive Occupational Health Care
- Annex Ordinance on Preventive Occupational Health Care

Operation of technical facilities

Ensure that technical facilities are operated and maintained exclusively by persons aged 18 years or older. They must be familiar with the facilities and processes, for example, through corresponding instruction and existing technical qualifications where applicable.

Employment restrictions

Consider the employment restrictions for pregnant and nursing mothers. In case of student interns or young students, for example, observe the Youth Employment Protection Act (Jugendarbeitsschutzgesetz, JArbSchG). Assign support staff for persons in need of special protection.

LEGAL BASIS
- Guide to Maternity Protection
- Youth Employment Protection Act

2.2.10 Project preparation

Before the start of project execution, the measures resulting from the hazard assessment have to be implemented and their effectiveness must be verified. The following aspects in particular should be considered here.

Work equipment and working materials

Inspect work equipment at the time of delivery to determine whether it is technically flawless and free of defects. This also applies to shared work equipment and facilities belonging to other companies. Provide the users with comprehensible instructions for use and, if necessary, directives; also see Chapter 1.4. In case of work equipment associated with special hazards, users have to provide you with proof of their operating qualifications. They must be instructed in the operation of the work equipment, for example, for cranes and industrial trucks. Through realistic project planning, ensure that working materials that create hazards for the employees are only bought and provided in the quantities needed for the work, see Prüfen von Arbeitsmitteln (Inspection of work equipment).

FURTHER INFORMATION
- Inspection of work equipment
- Chapter 1.4 Instruction and directives

Personal protective equipment (PPE)

Check whether PPE is required for the research project according to the results of the hazard assessment. Provide appropriate, suitable PPE – for example, hearing protection, safety goggles, safety shoes, hard hats, protective gloves. This also applies for temporary helpers, student interns and students. Responsible persons have to instruct the employees in the use of personal protective equipment and ensure that the PPE is actually used.

FURTHER INFORMATION
- Chapter 1.3 Evaluation of the work conditions
- Chapter 3.4 Personal protective equipment

Workstations

Make sure that the setup of workstations is ergonomic in order to avoid or at least minimise non-physiological strain for personnel. People who value an ergonomically designed work environment use work equipment that supports the smooth, error-free, safe and healthy completion of tasks. An ergonomically designed work environment helps maintain the performance and motivation of your colleagues. Workstations designed for working on a computer are a good example of workplace ergonomics.

They not only help employees relax and concentrate on their work, but also reduce physical strain. Additional significant criteria for ergonomic workplaces are:

- Adequate traffic routes (not blocked)
- Optimal lighting
- Healthy indoor climate
- Pleasant background noise

FURTHER INFORMATION
Chapter 3.1.2 Workplaces in buildings

Effects of weather

Check if weather influences are expected, for example, wind, thunderstorms, heat, sunlight or cold. Implement suitable technical and/or organisational protective measures as needed, for example, limiting the working time.

Provide protective equipment and devices as needed, for example, workwear and weather protection clothing, skin and UV protection, shelter or containers.

FURTHER ONFORMATION
Chapter 3.4 Personal protective equipment

Access restrictions and signage

Implement access restrictions according to the existing hazards and practical needs, for example, through verbal instructions, clearly recognisable prohibition signs, clear signals, barriers and locked areas. Any unnecessary presence of personnel in danger areas is prohibited.

Make sure that danger areas are adequately marked. Clear, readily visible instruction signs have to point out applicable behaviours (for example, instruction signs for wearing safety goggles and hearing protection).

Instruction

Instruct all project participants, including indirect personnel such as technical service, regarding the respective, relevant results of the hazard assessment. Aside from fundamental information about escape routes and the organisation of first aid, this includes the following points in particular:

- What hazards have been identified?
- Is there any mutual endangerment?
- What measures have been implemented (for example, containment, access restrictions, personal protective equipment)?
- Who are the applicable contact persons?
- Who has the authority to issue directives?
- What are the obligations of individual project employees?

2.3 Implementation of research projects

The implementation process includes preparation, the experiment and its conclusion as well as removal and documentation. What to observe for the preparation, execution and follow-up of research projects using various methods, types of radiation, materials and dangerous substances is described in Chapter 3 Technical information.

FURTHER INFORMATION
Chapter 3 Technical information

2.3.1 Management and responsibility

As described in Chapter 2.1 responsibilities have to be shown in an organisational chart. Supervising work in laboratories or technical centres is the responsibility of the managers in charge of those areas. The person with overall responsibility has to oversee this supervision and ensure coordination between the various areas during the entire project. This includes reviewing the contracted work with regard to health and safety measures. Every project employee with the authority to issue directives to other employees for part of the project is also responsible for the health and safety of those employees. To make intern and student support staff, for example, aware of their responsibilities as well, the topic of responsibility should be addressed during instruction in addition to the transfer of obligations.

FURTHER INFORMATION
Chapter 2.1 Management and responsibility in research projectsprojects

2.3.2 Approval of the laboratories and technical centre facilities

As the person responsible for a laboratory or technical centre, you with the help of the health and safety officer inspect all technical facilities, work equipment, working materials and test setups being used before the project starts. In doing so, you verify that they are in proper condition and used as intended, and then issue the approval.

2.4 Communication and documentation

Ensure that all necessary information for the completion of tasks during the entire project is provided for personnel. Make the scope of work transparent and discuss it with the participants, including the required safety precautions and health and safety measures.

Make it clear to the participants that they have to inform the responsible person – for example, the supervisor – before the start of experiments if they are not able to conduct them safely for physical or mental reasons.

Make sure that the following documents are on hand in the research area:

- Hazard assessment
- Proof of instruction
- Work instructions and directives as well as the instructions for use and operating instructions for the work equipment and facilities. They must be available at all times (also see TRGS, Technical Rules for Biological Agents (Technische Regeln für Biologische Arbeitsstoffe (TRBA)), laboratory ordinance, (Sample) directives ((Muster-) Betriebsanweisungen according to the Hazardous Substances Ordinance (GefStoffV))
- Required official permits
- Inspection and/or measurement records – for example, for noise, electrical engineering, statics
- Approval or acceptance documents

LEGAL BASIS

- Technical Rules for Hazardous Substances
- Technical Rules for Biological Agents

FURTHER INFORMATION

(Sample) directives according to the Hazardous Substances Ordinance

3 Technical information

Well planned and designed research institutes along with safe, healthy facilities, work equipment and procedures are prerequisites for working successfully. They are the result of diligent conceptual design, planning, procurement and preparatory work – see Section 1 and Section 2. You will find further technical information to support you with these steps in this section.

3.1 Organisation of the research institutes

Workspaces influence people's performance. Room layout, space, light, colours and climate – the room promotes or hampers productivity. The Workplace Ordinance identifies protection goals that must be achieved by institute management through appropriate measures. Note that structural and technical measures take precedence over organisational or individual protective measures. The hazard assessment determines what concrete measures are required in your research institute. Some aspects of the requirements for a workplace – workspaces, buildings and outdoor areas – are briefly summarised below

LEGAL BASIS
Workplace Ordinance

WEITERE INFORMATIONEN
Chapter 2 Organisation of research projects

3.1.1 Traffic zones in buildings

Traffic zones are areas providing access to rooms or buildings, for example, corridors, entryways, doors, stairs, escalators etc. Adequate escape and rescue routes must be provided in the design of traffic zones in buildings. Accessibility is an essential quality characteristic for the design of buildings.

FURTHER INFORMATION
- DGUV Information 215-111 "Accessible workplace design – Part I: Fundamentals"
- DGUV Information 215-112 "Accessible workplace design – Part II: General requirements"

Traffic routes

The design of traffic routes influences how persons move about in the building. Good traffic routes save time and help avoid disruptions and accidents. Tripping, slipping and falling accidents still top the list of all occupational accidents. The following design criteria have been proven in practice:

- Traffic routes are easy to negotiate on foot and by vehicles according to their intended use.
- The required escape route widths are taken into account for the dimensioning of traffic routes.
- The clear width of traffic routes is no less than 0.80 m at any point.
- Access routes to personal workstations have a minimum width of 0.60 m.
- Operator access routes – for example, access to heating – have a minimum width of 0.50 m.
- The permissible escape route lengths and division into fire compartments are taken into account in traffic route planning.
- Traffic routes and floors at workstations are level, adequately slip-resistant and free of tripping hazards. Height differences of more than 4 mm are considered tripping hazards in buildings. This also applies for thresholds in doors. Electrical connecting lines are not installed on top of floors. If this is unavoidable, electrical lines and cables lying on the floor are protected, for example, by cable bridges. See "Verkehrsflächen in Gebäuden", Traffic zones in buildings.
- Traffic routes are secured to prevent sliding off, falling in or falling down. See "Verkehrsflächen in Gebäuden", Traffic routes in buildings.
- Clear, transparent, non-textured surfaces, such as full glass doors or walls, in the vicinity of workstations and traffic routes are marked at eye level.
- Additional measures have to be implemented where, notwithstanding such marking, there is a risk of employees falling into transparent wall areas or being injured if the walls shatter. This may be the case, for example, in the area of landings, stairs or steps, in case of crowds or when transporting materials. Additional measures may include:
  - Using shatterproof glass or another shatterproof material
  - Installing fixed guards such as railings, nets or gratings
  - For protection against glass breakage, suitable shatter protection films are applied to existing glass walls that are not shatterproof
- Transparent walls and their components (frames, mounting parts, glass elements) are installed or anchored so that employees cannot be injured by falling parts.
- Stairs are designed so they can be negotiated safely.

LEGAL BASIS
Workplace Ordinance

FURTHER INFORMATION
- ASR A1.8 "Traffic routes"
- ASR A2.3 "Escape routes and emergency exits"
- ASR V3a.2 "Accessible design of workplace"
- DGUV Information 208-005 "Stairs"
- "Safe workplace planning and design"
- "Traffic zones in buildings"
- "Traffic routes in buildings"

Escape routes

Escape routes also include rescue routes defined in building regulations law if they are independently accessible. Aside from the maximum number of people on site, whether persons with local knowledge, for example, may be present must be considered in the hazard assessment.

Check whether the width of the escape routes in your workplaces meets the requirements of the technical rules for workplaces "Escape routes and emergency exits" (ASR A2.3 Fluchtwege und Notausgänge).

Number of persons (catchment area)	Clear width of main escape routes (in m)*
Up to 5	0,90
Up to 20	1,00
Up to 200	1,20
Up to 300	1,80
Up to 400	2,40

Table 1: Escape route widths according to ASR A2.3

* A reduction of the minimum width of corridors and doors is permissible depending on the number of persons (ASR A2.3).

FURTHER INFORMATION

ASR A2.3 "Escape routes and emergency exits"

Make sure that the **length of escape routes** in workplaces does not exceed 35 m (beeline distance) where no special hazards are present. The actual walking distance must not exceed 1.5 times the escape route length. For rooms with an elevated fire hazard and no automatic fire extinguishing system, the maximum escape route length is 25 m. It is 10 m for rooms with a hazard due to potentially explosive substances. For the storage or use of dangerous substances, requirements such as those in TRGS 500 "Storage of hazardous substances in non-stationary containers" (Lagerung von Gefahrstoffen in ortsbeweglichen Behältern) have to be observed.

Secondary escape route

The need for a secondary escape route arises from the hazard assessment under special consideration of specific conditions at the site or workplace. Examples are an elevated fire hazard or the number of persons who depend on the escape route.

For instance, a secondary escape route may be required for (storage) rooms with an area of more than 200 m², workspaces with more than 400 m² of floor space or due to other specific regulations (for example, the respective state building law, ASR A2.3).

Lighting and signage

Check whether adequate lighting is provided for all traffic routes:

- Traffic routes without steps: ≥ 50 Lux
- Traffic routes in the area of landings and steps: ≥ 100 Lux

Note that escape routes and emergency exitsrequire permanently visible signage. The signage must not be covered.

Ensure that emergency lighting is provided in case the general lighting fails.

LEGAL BASIS

Workplace Ordinance

FURTHER INFORMATION

- ASR A1.8 "Traffic routes"
- TRGS 510 "Storage of hazardous substances in non-stationary containers"

Flooring

The type of flooring influences safety while standing and walking. Flooring properties are adapted to the respective, specific type of use and stresses. Unsuitable flooring is a recurring cause of accidents in traffic routes.

- This means, for example, that flooring must have appropriate slip-resistant characteristics.
- When slippery substances are present regularly – for example, dust, water, oil or grease – the flooring must have a sufficient displacement space.
- In case of adjacent work areas with different slipping hazards, the slip resistance of the flooring may differ by no more than one class.

LEGAL BASIS
Workplace Ordinance

FURTHER INFORMATION
- "Safe workplace planning and design"
- "Flooring in workspaces and work areas with slipping hazards"

Doors and gates

The following design characteristics for doors and gates have proven themselves:

- Doors and gates are arranged so that no additional hazards are created, safe operation is possible and the minimum width of traffic routes is not reduced – also see "Traffic routes".
- Full glass doors are made of shatterproof, transparent materials, known as safety glass. Examples are laminated safety glass, tempered safety glass or transparent plastics with comparable safety characteristics. Wire glass is not safety glass.
- Doors with more than three-quarters of their surface made of a transparent material are marked so they can be clearly seen by all users.
- Power-operated gates are carried out so the resulting forces and movements do not pose any danger.

LEGAL BASIS
Workplace Ordinance

FURTHER INFORMATION
- "Safe workplace planning and design"
- ASR A1.7 "Doors and gates"
- ASR A1.8 "Traffic routes"
- ASR A2.3 "Escape routes and emergency exits"
- DGUV Information 208-014 "Glass doors, glass walls"
- DGUV Information 208-026 "Safety of power-operated revolving doors"

3.1.2 Workplaces in buildings

Changes to facilities and equipment may become necessary in research institutes because of new research projects or changes in the research field. For changes in the use of facilities or the furnishing of rooms that did not previously serve as a workspace, considering the aspects described in the following sections is especially important to ensure health and safety in research.

Workspaces

Properly designed workspaces make safe, healthy and productive work possible:

- In planning the workspaces, the space requirements and work tasks carried out in the rooms are analysed.
- Workspaces have sufficient floor space. For offices and computer workstations, the area per workstation including commonplace furnishings and pro-rata traffic zones is at least 8 to 10 m^2 on average.
- Interference effects are greater in open-plan offices (400 m^2) than in small rooms, and so the area per workstation is 12 to 15 m^2.
- Each workstation has an adequate free area to move. A clear, unobstructed area of at least 1.5 m^2 is required. It must have a depth and width of at least 1 m at all points (user area).
- Sufficient functional areas for windows and doors as well as moveable components on work equipment and furniture are provided so they can be opened unimpeded. Additional safety distances from furniture pull-outs are provided to avoid crushing, shearing and impact points.
- Electrical installations are included in planning according to the job requirements (number and demand of planned loads, location and dimensioning of the required connections in the room). They provide a supply of energy that does not impede the workflows and traffic in the workspace, and permits safe cleaning of the workspace, see "Safe workplace planning und design" (Arbeitsstätten sicher planen und gestalten).

LEGAL BASIS
Workplace Ordinance

FURTHER INFORMATION
- ASR A1.2 "Room dimensions and movement areas"
- DGUV Information 215-441 "Office planning – aids for the systematic planning and design of offices"
- "Safe workplace planning and design"

Windows

Windows have a considerable impact on personal wellbeing and provide adequate visibility for work. Some design notes that have proven themselves are provided below:

- The surface area of windows intended for lines of sight is sufficiently large. The ratio of transparent window, door or wall area/skylight area to the base area of the room is at least 1:10 (corresponds to about 1:8 measured in the unfinished state).
- To make looking out the window while sitting down possible, the bottom edge of the transparent surface for windows or in doors should be between 0.85 m and 1.25 m above the room's floor. This does not apply when walls and doors made mainly of glass or a transparent material provide a line of sight, rather than the windows.
- Windows generally have fall(-through) protection with a height of 1.00 m or at least 0.80 m and a depth of 0.20 m. If the fall height exceeds 12 m, fall(-through) protection with a height of 1.10 m is present regardless of the breast height.

FURTHER INFORMATION
- ASR A1.6 "Windows, skylights, transparent walls"
- "Safe workplace planning and design"

Sun protection

Sun protection devices can have a positive influence on the energy balance and climate in the building. They protect the employees against glare and reflections, especially when working at computer workstations and in the laboratory.

The following design aspects have proven themselves:

- The choice of sun protection is adapted to the local wind conditions and the use of the respective facilities. Various types of sun protection devices may be suitable depending on local conditions – sun protection glazing, exterior sun protection, sun protection integrated into the windows, interior sun protection or a combination.
- Appropriate sun protection control (time programmable) helps prevent exceeding a room temperature of 30° C.
- Sun protection systems are installed so that opening the windows for ventilation is not prevented.
- For emergency exits or windows intended as escape routes, sun protection can be operated manually or raised automatically when the power supply fails so that escape and rescue routes remain usable.

FURTHER INFORMATION

- ASR A1.6 “Windows, skylights, transparent walls”
- ASR A3.5 “Room temperature”
- ASR A3.6 “Ventilation”
- DGUV Information 215-444 “Sun protection in the office”
- “Safe workplace planning and design”
- Sun protection devices

Ventilation

According to the Workplace Ordinance and corresponding technical rules for workplaces ASR A3.5 “Room temperatures” (Raumtemperaturen) and ASR A3.6 “Ventilation” (Lüftung), workspaces must have a room temperature and breathable air that is conducive to health, with no unacceptable draughts. According to ASR A3.6, breathing air that is conducive to health is a requirement for all workplaces. Regular ventilation exchanges the indoor air with fresh outdoor air. Among other things, stale air, hazardous substances from materials (such as furniture, flooring), particles and biological agents (pathogens, for example) are transported away to ensure a good indoor air quality. Natural ventilation or mechanical ventilation is possible. Windows are most commonly used for natural ventilation. Intermittent ventilation with the windows and ideally also the doors open wide is most effective. A few minutes of ventilation is usually sufficient. Tilt windows are less effective for ventilation but can be sensible as a supplement to intermittent ventilation. With mechanical ventilation, centralised or decentralised ventilation systems (HVAC systems) continuously supply filtered fresh air to interior rooms from the outside. When air conditioning systems are used, the air can also be heated/cooled and humidified/dehumidified at the same time. In contrast to natural ventilation, properly configured HVAC systems guarantee the continuous, adequate exchange of air, regardless of outdoor weather conditions. When harmful substances are expected in room air based on the activities and work equipment or working materials, and substitution or using self-contained systems is not possible, the discharged substances have to be captured as close to the source as possible and properly discharged.

LEGAL BASIS

Workplace Ordinance

Lighting

Adequate, appropriate lighting improves employee concentration and performance. It summarises the requirements of ASR A3.4 "Lighting" (Beleuchtung und Sichtverbindung) and DIN EN 12464 "Lighting of work places".

LEGAL BASIS
Workplace Ordinance

FURTHER INFORMATION
- ASR A3.4 "Lighting"
- DGUV Information 215-442 "Lighting in the office"
- DIN EN 12464 "Lighting of work places"

Noise and acoustics

The less noise, the better for health and productivity. Workspaces are designed so that sound propagation is reduced, using noise reduction technology proven in practice.

Noise exposure in workplaces is kept as low as possible depending on the type of operation. The following noise exposure levels have proven themselves for various activities:
- For mainly mental activities – 55 dB(A)
- For simple or mainly mechanised office tasks and comparable activities – 70 dB(A)

At a daily noise exposure level or peak sound pressure level exceeding $L_{EX,8h}$ = 80 dB(A) or $L_{pC,peak}$ = 135 dB(C), the Occupational Safety Directive on Noise and Vibrations (Verordnung zum Schutz der Beschäftigten vor Gefährdungen durch Lärm und Vibrationen (Lärm VibrationsArbSchV)) applies for the protection of employees against actual or possible hazards.

Various measures described in the regulation have to be implemented above these thresholds. The values represent the lower threshold. When the daily noise exposure level or peak sound pressure level of $L_{EX,8h}$ = 85 dB(A) or $L_{pC,peak}$ = 137 dB(C) is reached or exceeded, further measures are required.

The sound insulating effect of personal hearing protection used by the employees is disregarded for the application of the threshold values.

The following table provides a rough overview of the required measures and refers to the corresponding legal sources.

LEGAL BASIS
- Ordinance on Preventive Occupational Health Care
- Workplace Ordinance
- Occupational Safety Directive on Noise and Vibrations
- Regulation on Safety and Health Protection for the Use of Personal Protective Equipment at Work (PSA-BV)

FURTHER INFORMATION
- ASR A3.7 "Noise"
- Noise protection worksheet IFA-LSA 01-234 "Room acoustics in industrial workspaces"
- TA Lärm "Technical instruction on protection against noise"
- TRLV Lärm "Technical rules for the Occupational Safety Directive on Noise and Vibrations – Part 2: Measuring noise"
- DGUV Rule 112-194 "Use of hearing protection"
- DGUV Information 209-023 "Noise in the workplace"
- DGUV Information 215-443 "Acoustics in the office"

Daily noise exposure level $L_{EX,8h}$	Measures	Legal basis
≥ 80 dB(A)	Duty to inform and instruction with exercise	Section 11 of the LärmVibrationsArbSchV Section 3 (1) of the Regulation on Safety and Health Protection for the Use of Personal Protective Equipment at Work (PSA-BV)
> 80 dB(A)	Provide hearing protection	Section 8 of the LärmVibrationsArbSchV
	Recommended preventive care	Section 5 of the ArbMedVV
≥ 85 dB(A)	Duty to inform and instruction with exercise	Section 11 of the Lärm VibrationsArbSchV Section 3 (1) of the PSA-BV
	Provide hearing protection	Section 8 of the LärmVibrationsArbSchV
	Mandatory use of hearing protection (employee) and monitoring obligation (employer)	Section 8 of the LärmVibrationsArbSchV
	Compulsory preventive care	Section 4 of the ArbMedVV
> 85 dB(A)	Noise reduction programme	Section 7of the LärmVibrationsArbSchV
	Identification of noisy areas	Section 7of the LärmVibrationsArbSchV

Table 2: Measures required when the daily noise exposure level is reached or exceeded
* See overview of abbreviations on page 74

Ergonomics

An ergonomic work environment not only facilitates relaxed and focused work, but also reduces physical strain for the employees. People who value an ergonomically designed work environment use work equipment that supports the smooth, error-free and safe completion of the work tasks.

- Establish favourable table layouts (free-form, angled combination, rectangular table etc.)
- Make sure that working materials and work equipment are accessible (height and depth of the tables, cabinets etc.)
- Plan workstations so that employees are not always sitting down (printer in a separate room, height-adjustable table and the like); provide standing aids for standing workstations
- Ensure good usability of the work equipment (control elements easy to access)
- Take accessibility into account

FURTHER INFORMATION

- DGUV Information 213-850 "Working safely in laboratories – fundamentals and guidelines"
- DGUV Information 215-410 "Computer and office workstations – design guidelines"
- DIN EN 14056 "Laboratory furniture – Recommendations for design and installation"
- DIN EN 13150 "Workbenches for laboratories in educational institutions – Dimensions, safety and durability"

Safety fences

For work surfaces on scaffolding, towers, roofs and rooftop terraces or in other high places, complete a hazard assessment to determine whether and what fall protection is required. Fall protection is required for a fall height of 1.0 m or more. This may be a railing with a height of 1.0 m (1.1 m for a fall height of more than 12.0 m) with a knee rail at a height of 0.5 m and a 0.1 m high skirting board. As a rule, it is carried out as a fixed railing with an allowable horizontal load of at least 1000 N/m. An allowable horizontal load of 500 N/m is sufficient for catwalk railings.

FURTHER INFORMATION

ASR A2.1 "Protection against falls and falling objects, entering danger areas"

Access to elevated workplaces

Provide structural traffic routes such as stairs or vertical ladders for access to elevated, permanent areas and workplaces. For temporary access to elevated areas and workplaces, such as scaffolding, install stair towers, interior ladder access or securely attached single ladders.

The Industrial Safety Directive (Betriebssicherheitsverordnung (BetrSichV)) and corresponding technical rules regulate the use of ladders for access to elevated workplaces. Restrictions apply to the use of ladders as elevated workplaces and to access and positioning procedures with the aid of ropes. These are only permitted in cases where, due to the low level of danger and short duration, the use of other, safer work equipment is disproportionate and the hazard assessment confirms that the work can be carried out safely. Due to the risk of falls and greater ergonomic strain, portable ladders may only be used as an elevated workplace if the employee stands with both feet on a step or platform and the location on the ladder is no higher than 5 m above the surface it stands on. When the employee stands at heights between 2 and 5 m, the work may only be carried out under certain conditions (see TRBS 2121-2 "Danger to employees while using ladders" (Gefährdung von Beschäftigten bei der Verwendung von Leitern)).

Regardless, institute management has to ensure that persons can be rescued from elevated workplaces (rescue concept).

LEGAL BASIS

Industrial Safety Directive

FURTHER INFORMATION

- TRBS 2121 Part 1 "Danger to employees due to falling while using scaffolding"
- TRBS 2121 Part 2 "Danger to employees while using ladders"
- TRBS 2121 Part 3 "Danger to employees due to falling while using access and positioning procedures with the aid of ropes"
- TRBS 2121 Part 4 "Danger to employees due to falling – exceptional lifting of employees using work equipment not intended for the purpose"

Protection against falling objects

To ensure that nobody is injured by falling objects when work is carried out on multiple levels or, for example, in case of a gallery that runs around the experimental hall, skirting boards with a minimum height of 0.1 m have proven themselves.

Make sure that all objects, equipment and devices that may fall down or tip over are attached and secured.

Regularly check that storage facilities are being used correctly (heavy objects lower down, lighter ones higher up) and, for example, that shelves are not overloaded.

FURTHER INFORMATION

- ASR A2.1 "Protection against falls and falling objects, entering danger areas"
- DGUV Information 208-061 "Lagereinrichtungen und Ladungsträger"

3.2 Technology and operational processes

3.2.1 Work equipment and technical facilities

Choose **work equipment** that can be used safely with no health impairment, meets the operational requirements and is compatible with the conditions of use. Some work equipment designated for use in research institutes is not expressly intended for this use by the manufacturer. If such work equipment is to be used under the specific conditions in the research institute anyway, you have to ensure safety by other means. It is therefore of special importance to ensure, during the procurement and use of equipment, that hazards, injuries and other health impairments are avoided. In research institutes, facilities and equipment are also fabricated, further developed and operated (internally), especially for research purposes. If equipment, facilities or test setups are built in-house, certain manufacturer obligations have to be met depending on their type and use. This also applies for equipment, facilities and test setups built solely for internal use. Perform a diligent review of what obligations you have to meet and under what circumstances the equipment, facility or test setup may be operated for research purposes.

Uncommon safety measures are sometimes implemented in ground-breaking scientific-technical applications since established solutions are not available.

Sometimes the “best available technology” actually has to be newly defined in this environment. Compliance with numerous provisions and laws is nonetheless required. For example, a declaration of conformity has to be prepared under certain circumstances (also see DGUV Information 202-002 “Fabrication and operation of facilities and equipment for research purposes”, (“Herstellen und Betreiben von Geräten und Anlagen für Forschungszwecke”).

FURTHER INFORMATION

DGUV Information 202-002 “Fabrication and operation of facilities and equipment for research purposes”

The following approach has proven itself for the **selection and evaluation** of work equipment:

1. Determination of the intended areas of application and hazard notices according to the manufacturer
2. Comparison of the manufacturer's information with the operating conditions for the planned use in the operation
3. Evaluation whether additional hazards arise in case of deviations between the manufacturer's information and the type of planned use
4. Establishment of measures to reduce the hazards according to the manufacturer's information and the changed conditions of use
5. Preparation of a corresponding directive

In evaluating the hazards and deriving measures, one of the points to consider is that persons are not endangered by the movement of **technical equipment**, for example, cranes or mechanical test setups such as robots.

The safe operation requirement includes the following:

- Technical equipment is secured to prevent unauthorised use and unintentional movements
- Hazard areas on moving technical equipment are secured, for example, by safety shut-off bars, light barriers or continuous monitoring
- The movement process of such equipment and the surroundings are fully visible to the operators. In case of limited visibility, movement has to be clearly signalled to the operators using symbols, image transmission or voice transmission.
- Fixed and moveable components and superstructures pass by each other so that no pinching or shearing points are created.

Wear and damage may occur over time as work equipment is used. This in turn can lead to hazards for users. Therefore, the work equipment used at research institutes has to be inspected regularly and, depending on the work equipment, tested. Before work equipment is used, it has to be checked for apparent defects by means of a visual inspection and, where applicable, a functional test. Aside from these inspections and tests, recurring inspections have to be performed at appropriate time intervals. How, by whom and at what intervals this needs to be done is described, for example, in TRBS 1201 and TRBS 1203. The concrete scope of inspection and the intervals for specific work equipment have to be determined and established in the hazard assessment. For one-shift operation, a one-year inspection interval has proven appropriate for work equipment in many cases. The inspection results must be retained at least until the next inspection.

Certain work equipment is subject to mandatory monitoring because of especially serious hazards. To ensure operating safety for this equipment, it is subject to special, regularly recurring inspections. The applicable equipment, the respective inspection intervals and the requirements for inspectors are regulated by the BetrSichV in Section 18 and Annex 2. Examples include lifts, pressure equipment and work equipment used in explosion hazard zones. A flowchart for the management of equipment subject to monitoring is provided in Figure 5 "Management of equipment subject to monitoring".

LEGAL BASIS

- Industrial Safety Directive
- TRBS 1201 "Inspection and testing of work equipment and equipment subject to monitoring"
- TRBS 1203 "Persons qualified to conduct inspections"

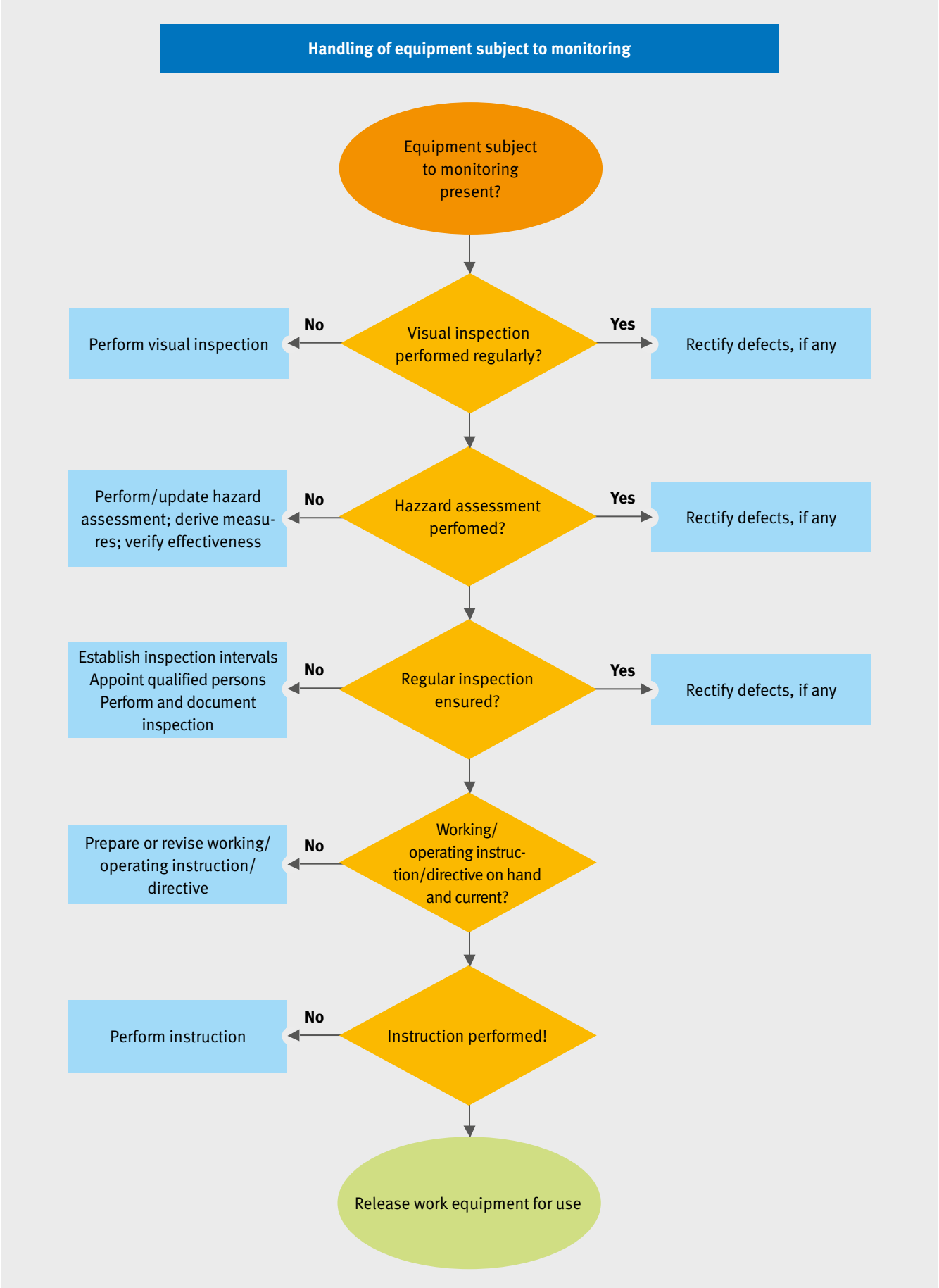


Figure 5: Management of equipment subject to monitoring

3.2.2 Electrical systems and equipment

Electrical systems and equipment may only be built, modified and maintained by or under the management and supervision of an electrically skilled person. They also require regular inspection. The corresponding inspection intervals have to be established based on the hazard assessment and the manufacturer's information. However, stationary electrical systems have to be inspected at least every 4 years and portable systems at least every 2 years according to DGUV Regulation 3 "Electrical systems and eqipment". Regardless of the established inspection intervals, check all portable electrical equipment prior to each use by means of a visual inspection for

- mechanically sound condition and functionality, and
- sound condition of the portable connecting and extension cables.

This applies in particular for electrical equipment that, for example, is used for outdoor field tests and therefore exposed to exceptional conditions. In case of apparent damage that may impair safety (insulation damage, for example), using the equipment is prohibited. Using a mobile PRCD is recommended if sufficient protection of the cables (ground fault circuit interrupter) is not assured.

FURTHER INFORMATION

- DGUV Information 203-004 "Use of equipment with increased electrical hazards"
- DGUV Information 203-005 "Selection and operation of portable electrical equipment by areas of application"
- DGUV Information 203-071 "Recurring inspections of electrical systems and equipment – organisation by the employer"
- DGUV Information 203-072 "Recurring inspections of electrical systems and stationary electrical equipment"

LEGAL BASIS

DGUV Regulation 3 "Electrical systems and equipment"

Connection of "external" equipment

All "external" electrical equipment used in research institutes and connected to the grid (for example, a microwave oven or coffee machine brought from home) has to be inspected by an electrically skilled person. The inspection can be initiated and documented by the owner. To exclude hazards due to private equipment that has not been inspected, bringing and connecting private equipment can be generally prohibited at the institute.

3.2.3 Transportation and storage

Suitable hoisting and transport equipment must be provided for lifting and transporting heavy or bulky loads. Examples include platform trucks, pallet cages, hand trucks, lift trucks and lifting equipment. This applies for instance in case of larger test setups or when larger quantities of sample materials are used. Lift trucks and lifting equipment may only be used by persons with corresponding training and instruction.

For manually lifting and carrying loads – such as crates with materials and equipment for outdoor excursions or test setups – the loads to be moved and the frequency of these processes must be minimised on principle. The actual strain on persons caused by manually handling heavy loads can vary depending on the personal constitution determined by age, gender and fitness level (strength, endurance). The Federal Institute for Occupational Safety and Health (BAuA) developed the "Key indicator methods" for evaluating hazards due to the manual handling of loads.

Items may only be stored in suitable locations. Items must be stored so that traffic routes and movement areas remain unobstructed and the minimum clearances are maintained. Placing and storing items in escape routes and in front of emergency exits is prohibited. Items in storage must be stable and, where necessary, secured to prevent unintentional movement and repositioning (pipes, for example).

For storage in racks, the structural safety and sufficient load bearing capacity of the racks must be given. Fixed racks with a shelf load of more than 200 kg or a section load of more than 1000 kg have to be labelled with the following information, clearly visible and permanently:

- Manufacturer or importer
- Type designation
- Year of manufacture or order number
- Permissible shelf and section loads

Corresponding labelling is also recommended for racks with a lower shelf/section load to prevent overloading.

Storage facilities and equipment must be loaded so that stored goods cannot fall out or down. This includes adapting storage facilities and equipment to changes in the goods being stored. When racks are subject to damaging influences that can lead to a hazard for the employees, for example, loading and unloading stored goods with industrial trucks, the racks have to be inspected regularly by a competent person. The requirements for inspectors, the scope of inspection and inspection intervals are found in DGUV Information 208-043 "Safety of racks" (Sicherheit von Regalen).

FURTHER INFORMATION

- DGUV Information 208-043 "Safety of racks"
- DGUV Information 208-061 Lagereinrichtungen und Ladungsträger
- "Hazard assessment with the key indicator methods"

Chapter 3.3.3 Storage of dangerous substances

3.3 Laboratories and research activities

The object of research projects is to gain knowledge. This means that some interrelations, and therefore possibly also hazards and stresses, are still unknown. Forward-looking, regular assessment of the hazards (mechanical, chemical, electrical and biological hazards; hazards due to ionising or laser radiation etc.), deriving measures and verifying their effectiveness is therefore all the more important. This applies for experimental research in particular. The minimisation principle is especially important when working with new substances and unknown organisms or modes of action: As few persons as possible should be present, with activities reduced to the smallest quantities and safe operating methods (for example, working in closed systems). If this leads to working alone, precautions have to be taken to ensure that first aid, for example, is nevertheless assured. The psychological aspects of working alone also have to be considered. With regard to protective measures, technical measures take precedence over organisational and personal measures. Nevertheless, personal protective equipment such as safety goggles, a lab coat and special protective gloves is often required (in addition). Deviations from the recognised standards of good practice, described among other things in TRGS, are only permitted if the same level of safety is assured in other ways – proof is required on a case-by-case basis.

Where the term “laboratory” is used in the following, this refers to chemical, physical and biological laboratories except when further differentiated. The requirements for laboratories can also be transferred to technical centre facilities. However, hazards may have to be reassessed for this transfer because they can change during scaling from the laboratory to the technical centre scale. Quantity-dependent hazards exist, for example, when handling dangerous substances and, in particular, with regard to explosion hazards.

Persons with very different qualifications may work in laboratories: They range from scientific management of research institutes to members of the research staff, doctoral candidates and, where applicable, students during their diploma thesis or internship and student interns. Tradespeople, custodians and cleaning staff may also work in laboratories in the course of their jobs. Laboratory personnel must be competent for the activities being carried out. The required competence depends on the materials/dangerous substances being used, the quantities of dangerous substances, substance properties, type and number of activities, work equipment type and number (including apparatuses, tools, equipment) and on experiment/reaction control. Competence is determined by the type, content and duration of training, work experience and experience with

the activities being carried out. Corresponding hazard assessments have to be prepared for each laboratory and all required activities. Depending on the hazard, steps must be taken to ensure that persons without sufficient qualifications do not gain (unsupervised) access (access restriction).

An approval or permit can be sensible, especially for activities of tradespeople. It establishes the date and time of access as well as the required protective equipment and persons responsible. The less competent and experienced the person working in the laboratory is (for example, in case of student internships), the more important implementing automated protective measures is, since one must expect that protective measures that depend on actions (such as correct operation of the fume cupboard) will not be executed correctly or at all. Cleaning and waste disposal in laboratories require particularly thorough planning to avoid the displacement of dangerous substances and improper disposal of hazardous waste. To protect cleaning staff from specific hazards in laboratories, the required cleaning and disposal tasks in laboratories must be evaluated separately depending on the type of laboratory and the applicable hazards and substances. Steps must be taken to ensure that cleaning staff is instructed about the required measures in a comprehensible form and language, and can carry out the work without endangering themselves or others. Since the work of cleaning staff is often performed outside the usual working hours of laboratory personnel, experiments that run unsupervised or measuring setups that run overnight may also pose a hazard to cleaning staff if they have access to the corresponding areas.

Laboratories have to be equipped and operated according to the applicable regulations, with the best available technology. For research projects and any form of research cooperation or joint project, it is essential to clarify in advance who is in charge of management and therefore responsible for the organisation of health and safety. This includes, for example, the regular inspection of work equipment as described in Chapter 3.2.

URTHER INFORMATION

- DGUV Information 211-006 “Safety and health protection through coordination”
- DGUV Information 211-010 “Safety through directives”
- DGUV Information 212-139 “Emergency call options for persons working alone”
- DGUV Information 213-035 GHS poster “Physical-chemical hazards and environmental hazards”
- DGUV Information 213-036 GHS poster “Fire and explosion hazards”
- DGUV Information 213-037 GHS poster “Health hazards”
- DGUV Information 213-850 “Working safely in laboratories – fundamentals and guidelines”
- DGUV Information 215-830 “Cooperation between companies under contracts for work and labour”
- TRGS

Chapter 3.2 Technology and operational processes

3.3.1 Construction and furnishing of laboratories

As workplaces, laboratories are subject to the Workplace Ordinance and the concrete requirements defined by the ASR. The BetrSichV also applies. Depending on the type of laboratory and the activities being carried out, there are however additional provisions regarding the required facilities, distances and furnishings. For example, TRGS 526 applies for laboratories where work with dangerous substances is carried out. TRBA 100 is relevant when handling biological working materials. The requirements of the Genetic Engineering Safety Ordinance (Verordnung über die Sicherheitsstufen und Sicherheitsmaßnahmen bei gentechnischen Arbeiten in gentechnischen Anlagen (GenTSV)) have to be observed when work with genetically modified organisms is carried out. When working with pathogens, the requirements of the IfSG apply. The Radiation Protection Ordinance (Strahlenschutzverordnung (StrSchV)) imposes requirements for the handling of radioactive substances and ionising radiation.

Safety in laboratories is determined to a large extent by construction, furnishings, procedures, operation, equipment and the qualifications of laboratory personnel. Thus the construction and equipment determine the activities that can be carried out in laboratories to a large extent. In particular, TRGS 526, § 6 imposes requirements for workplace design. Aside from operating areas and traffic zones, this includes escape and rescue routes, doors, floors, ventilation, extraction systems, workbenches and their storage spaces, supply lines and fittings, emergency showers, and electrical systems and equipment. TRGS 526, § 7 (German symbol for paragraph), covers the required inspections for various facilities. DGUV Information 213-850 "Working safely in laboratories – fundamentals and guidelines" (Sicheres Arbeiten in Laboratorien – Grundlagen und Handlungshilfen) provides concrete information for implementing the various legal regulations that apply to laboratories. For example, it contains detailed information about workplace design in laboratories and describes the various areas of activity (documentation zone and experimental zone). It has extensive information on the required equipment and its safe use, which cannot be discussed here in detail.

LEGAL BASIS

- Workplace Ordinance
- Industrial Safety Directive
- Hazardous Substances Ordinance
- Genetic Engineering Safety Ordinance
- Infection Protection Act
- Radiation Protection Ordinance
- TRGS 526 "Laboratories"
- TRBA 100 "Protective measures for activities involving biological agents in laboratories"

FURTHER INFORMATION

DGUV Information 213-850 "Working safely in laboratories – fundamentals and guidelines"

3.3.2 Activities with dangerous substances

Definition of dangerous substances

Dangerous substances in terms of § 2 (1) of the GefStoffV are

1. dangerous substances and preparations according to § 3,
2. potentially explosive substances, preparations and products,
3. substances, preparations and products from which substances according to no. 1 or 2 are produced or released during production or use,
4. substances and preparations that do not meet the criteria according to no. 1 through 3 but, due to their physical-chemical, chemical or toxic properties and the way they are present or used in the workplace, may endanger the health and safety of employees,
5. all substances to which a workplace concentration limit has been assigned.

Thus the definition covers typical laboratory chemicals including pure substances, solutions, suspensions or gases. It also applies to the

desired reaction products or by-products and contaminants as well as unexpected reaction products. Dangerous substances can also be released by the breakdown of the matrix during activities with substances, preparations and products not classified as hazardous. Likewise, substances with no hazard characteristic but with properties that can result in hazards may also be dangerous substances (for example, unstable substances or substances that can lead to a hazard in contact with each other or due to their temperature and thermal capacity). Examples include hot salt melt or cryogenic liquefied gases. Substances that appear harmless at first glance, such as cellulose powder, can form an explosive atmosphere when mixed with air – like all other kinds of combustible dust. The properties of and therefore hazards posed by a substance also depend on the respective grain size (particle size). Many metals are non-combustible at a coarse grain size but, as fine powders, may spontaneously ignite in contact with atmospheric oxygen.

Hazards and hazard assessment

In order to nevertheless work safely with these substances, the technical, organisational and personal protective measures required by the GefStoffV have to be implemented. This includes regular reviews of the technical protective measures with regard to function and effectiveness. The type and scope of the inspection and the inspection intervals are based on the hazard assessment. Establishing them is the responsibility of institute management. The inspections must be documented and have to be performed at least every three years.

Also, the inspections have to be carried out exclusively by appointed personnel with the required technical qualifications.

The fume cupboard is one of these technical measures. It can protect against effects due to physical-chemical properties (for example, the formation of an explosive atmosphere) and against health hazards. Therefore, activities with new or not yet adequately studied substances may, on principle, only be carried out in fume cupboards or facilities with a comparably high protection level (for example, inert gas box/glove box).

The following hazards due to dangerous substances are typically expected in laboratories:

- Fire and explosion hazard
- Health hazards
- Hazards due to unknown, violent or continuous reactions
- Eye and skin hazards due to corrosive and irritating substances

Other hazards and stresses relevant for laboratory activities also exist. They must not be disregarded in the hazard assessment and may affect the safe handling of dangerous substances:

- Lighting that is inadequate or not appropriate for the task
- Unfavourable room climate conditions
- Containers with positive or negative pressure
- Lines with pressurised liquids (e.g. hydraulic lines) or gases (e.g. compressed air)
- Hot or cold surfaces and media
- Hazardous surfaces and edges (for example, rotating grinding wheels, broken glass containers, needles and the like)
- Noise
- Mechanical hazards due to moving parts of machinery and equipment
- Skin hazards when working in wet conditions (for example, due to wearing gloves)
- Slipping hazards due to wet conditions and other media (machine oil, for example)
- Tripping hazards
- Stresses on the locomotor system due to repetitive tasks or constrained posture (during pipetting, for example)
- Mental stress due to monotonous or repetitive activities, time pressure, isolation, high demands on concentration
- Burdens on employees caused by PPE
- Ionising radiation
- Electromagnetic fields
- Optical radiation (UV, laser, IR)
- Biological working materials
- Working alone

Thus it is important to consider possible interactions in the hazard assessment as well (for example, ignition of combustible air-vapour mixtures due to laser radiation). Measures for the protection of employees against dangerous substances have to be compatible with protective measures against other effects. The experts for the respective areas should therefore be involved in preparing the hazard assessment.

Employee qualifications

Laboratory personnel must have the technical qualifications for the respective activity in order to work safely in laboratories. The requirements regarding the technical qualifications depend on:

1. The dangerous substances used
2. The quantities of dangerous substances
3. The substance properties
4. The number and types of activities
5. The number and types of work equipment (for example, apparatuses, equipment and machinery)
6. Reaction control (for example, the possibility of continuous reaction, pressurisation)

The technical qualifications depend on the type and duration of training, work experience in the respective area and experience with the activities being performed.

If the technical qualification level is comparatively low, protective measures that depend on persons and their actions can be expected to be less effective than when they are carried out by competent and experienced persons in the laboratory. That is the case, for example, when laboratory personnel changes frequently, e.g. in the course of a student internship. This has to be counteracted with an increased frequency and intensity of instruction on the one hand. On the other hand, automated protective measures have to be implemented to replace personal protective measures where possible.

Handling dangerous substances

Detailed preparation and follow-up of the work is also important for the handling of dangerous substances.This includes the analysis of hazards for the individual work steps, for example:

Prior to the work:

- Obtain information about the dangerous substances that are used or produced during activities
- Request the current safety data sheet from the manufacturer
- Internet databases are a source of useful information (for example, GisChem, substance database GESTIS)
- Determine limit values and evaluation criteria
- Review substitution options (less dangerous substances, methods etc.)
- Prepare/update the register of dangerous substances
- Determine the expected exposure level and the type of exposure in the workplace for all activities, and evaluate the fire and explosion hazards
- Plan and implement protective measures
- Organise the procurement and cleaning of work clothing (lab coats, for example) and provide the same (for the selection of suitable protective gloves, see Chapter 3.4
- Use dangerous substances in closed systems where possible
- Implement extraction at the point of origin for the dangerous substance where possible
- Minimise the number of employees exposed to the dangerous substance
- Prepare directives and post them at a suitable location
- Instruct employees according to the directives
- Integrate occupational medicine toxicology advice in the instruction
- Review preventive occupational medicine and organise, offer and implement as needed
- For hazardous activities with carcinogenic or mutagenic substances in category 1A or 1B, maintain a register of exposed persons
- Organise appropriate storage for dangerous substances when the small quantity limit according to TRGS 510 is exceeded
- Store substances and mixtures of the following classifications so that access is

restricted to competent, reliable personnel:
  - Acute toxicity, category 1, 2 or 3
  - Specific target organ toxicity, category 1
  - Carcinogenic, category 1A or 1B
  - Mutagenic, category 1A or 1B
- Prepare a skin protection plan
- Observe employment restrictions:
  - Young people may only be exposed to dangerous substances when this is the only way to achieve the educational objective, the supervision of a competent person is assured and the air limit value is not exceeded
  - Pregnant and nursing women must not be exposed to dangerous substances where this constitutes an unreasonable hazard in terms of Section 11 and 12 of the MuSchG

During the work:
- Comply with the protective measures and rules of conduct according to the directive (including the proper use of extraction, use of PPE, prohibition of food intake)
- Have appropriate means of collection or binding agents ready
- Have suitable extinguishing agents ready when handling dangerous substances that are combustible, inflammable or subject to spontaneous combustion, or during activities with fire hazards
- Change gloves (according to the penetration time) and filters in a timely manner
- Mark dangerous substance containers with pictograms and the name of the dangerous substance. Additional identification with H-statements is recommended
- Clean up contamination on the outside of the dangerous substance container immediately
- Observe the skin protection plan
- Verify the effectiveness of the protective measures regularly

After the work:
- Properly store the dangerous substance containers, if necessary under lock and key
- Properly clean up contamination in the workplace
- Properly dispose of residues; note possible hazardous reactions in the waste container
- Properly clean the PPE and work clothing
- Observe the skin protection plan

LEGAL BASIS
- Ordinance on Preventive Occupational Health Care
- Biological Agents Ordinance
- CLP Regulation
- DGUV Principle 313-003 "Basic requirements for specific continuing education measures as part of the technical qualifications for conducting the hazard assessment for activities with dangerous substances"
- Hazardous Substances Ordinance
- Genetic Engineering Safety Ordinance
- Youth Employment Protection Act
- Guide to Maternity Protection
- Radiation Protection Act

FURTHER INFORMATION
- GESTIS substance database
- DGUV Information 213-026 "Health and safety in university internships with chemicals"
- DGUV Information 213-034 "GHS – Globally Harmonized System of Classification and Labelling of Chemicals"
- DGUV Information 213-039 "Dangerous substances at universities"
- DGUV Information 213-044 "Dangerous substances at universities"
- DGUV Information 213-079 Activities with dangerous substances – information for employees"
- DGUV Information 213-080 "Health and safety measures for activities with dangerous substances"
- DGUV Information 213-084 "Storage of dangerous substances"
- DGUV Information 213-850 "Working safely in laboratories – fundamentals and guidelines"
- DGUV Information 213-857 "Laboratory fume cupboards – types and safe operation"
- TRGS 400 "Risk assessment for activities involving hazardous substances"
- TRGS 510 "Storage of dangerous substances in portable containers"
- TRGS

Chapter 3.4 Personal protective equipment

3.3.3 Storage of dangerous substances

The overall responsibility for the storage of dangerous substances rests with institute management. However, institute management can transfer part of the responsibility, for example, to laboratory management or a person responsible for the storage of dangerous substances, in particular through a transfer of obligations. In doing so, steps must be taken to ensure that the person has sufficient knowledge regarding the safe handling of dangerous substances and obtains corresponding technical training and continuing education. That being said, the responsibility for the selection, organisation and monitoring of this person remains with top management/ institute management.

In particular, the persons in charge have to ensure that

- the storage facility is used only as intended,
- all substances stored there are properly identified (at least with the name and pictogram) and handled safely,
- the storage facility is in proper condition, notably the protective devices,
- the hazards are assessed and protective measures are established,
- compliance with occupational hygiene, occupational safety and environmental protection is assured,
- only qualified employees are selected,
- the employees undergo regular qualification, continuing education and instruction,
- the activities and workflows are coordinated,
- rules of conduct for external persons are prepared and followed,
- measures for emergencies are implemented.

Depending on the type and size of the storage facility and the substances stored there, permits for its operation may have to be obtained, for example:

- Water law permits
- Permits under state building regulations law
- Permits under the Federal Immission Control Act (Bundesimmissionsschutzgesetz (BImschG))

For the storage of inflammable liquids, a permit under the BetrSichV may also be required.

In the course of the hazard assessment, suitable protective measures – including personal protective equipment – and measures for the verification of effectiveness have to be established for the storage of small quantities for daily use and for the storage of dangerous substances. Aside from the dangers to human health, potential environmental hazards also have to be examined for the storage of dangerous substances and corresponding protective measures have to be implemented. Special storage provisions also apply, for example, for the storage of combustible or oxidising dangerous substances. TRGS 510 outlines protective measures for the storage of hazardous substances in non-stationary containers using the best available technology. By implementing the protective measures according to TRGS 510 institute management can rest assured that the requirements according to the GefStoffV are met.

LEGAL BASIS

- Federal Immission Control Act
- Industrial Safety Directive

FURTHER INFORMATION

- TRGS 201 "Classification and labelling for activities with dangerous substances"
- TRGS 400 "Risk assessment for activities involving hazardous substances"
- TRGS 510 "Storage of hazardous substances in non-stationary containers"
- TRGS 800 "Fire protection measures"
- TRGS 720 "Dangerous explosive mixtures"
- DGUV Information 213-084 "Storage of dangerous substances"

3.3.4 Use of laser equipment

A wide variety of laser applications are used in research institutes. They range from lasers as the object of research to the use of measuring equipment to laser cutting and writing, to name just a few examples. However, laser radiation poses a hazard for the eyes and skin. Powerful laser radiation can also trigger chemical reactions and physical processes in the laboratory, destroy materials and act as an ignition source. Therefore, protective measures according to the laser class and the resulting hazards are required when using lasers. Examples include:

- Eye hazards must be avoided when using laser pointers (preferably laser class 1, at most laser class 2). Never direct the laser pointer towards the audience during presentations. Keep the projection surface free of highly reflective objects.
- Install projection equipment, especially high-performance projectors, so that the radiation cannot pose a hazard for persons (ceiling installation, for example). The planned position and eye level of the presenter also have to be taken into account.
- When class 3R, 3B and 4 lasers are used, a laser protection officer is required to monitor operation.
- For lasers above class 2, the beam path has to be clearly and permanently marked.
- Additional protective measures are required for laser class 3 and up:
  - Access restriction (key or code card) or shielding of laser beams (laser radiation conducted in tubes or another enclosure)
  - When the enclosure is opened, the laser has to immediately turn off automatically
  - Reflective items are not permitted to enter the beam path; jewellery has to be removed
  - The use of additional PPE such as laser safety goggles may be required in coordination with the laser protection officer
  - At the entrance to laboratories with class 3 or higher lasers, there should be an antechamber where no hazardous radiation is present, in order to put on and take off PPE and jewellery
  - Instruction of personnel

Further information on the legal provisions for the use of lasers is found in the "Technical Rules of the Occupational Safety Ordinance on Artificial Optical Radiation" (Technische Regeln zur Arbeitsschutzverordnung zu künstlicher optischer Strahlung (TROS)).

FURTHER INFORMATION

- "Ordinance on Artificial Optical Radiation"
- DGUV Information 203-042 "Selection and use of laser safety and alignment glasses"
- DGUV Information 213-729 "Hazard assessment recommendations of the accident insurance providers (EGU) according to the Hazardous Substances Ordinance – Laser labelling of plastics"
- DGUV Information 203-093 "Hazard assessment guidelines for the operation of open laser devices for processing materials with manual guidance or manual positioning"
- Laser radiation – guidelines for the hazard assessment

3.3.5 Use of ultraviolet (UV) radiation

Ultraviolet (UV) light is used in laboratories for a variety of purposes. Aside from killing pathogens and viruses on surfaces or in water treatment this includes, for example, the hardening of certain materials or setups for UV resistance testing.

Direct or indirect UV exposure can cause inflammation and burns of the cornea and conjunctiva. In addition to premature skin ageing, repeated exposure can cause skin cancer. The eyes and skin of personnel need to be protected as a result. UV emitters therefore have to be installed and operated so that the skin and eyes of personnel are not damaged. This can be realised through corresponding positioning (no direct line of sight) or with shielding in the form of a non-combustible enclosure. Immediate shut-down of the UV emitter when the enclosure is opened has proven itself. The on state must be clearly identifiable. If the exposure of persons cannot be reliably prevented, the irradiation dosage has to be minimised, for example, through organisational measures such as short exposure times. Identification of the irradiated zone on the floor is recommended for UV antechambers. After the technical and organisational measures have been exhausted, PPE such as protective clothing, light protection preparations, safety goggles and face shields can be used to protect the eyes and skin.

Ozone may be produced, especially when high-powered lamps are used. Ventilation measures are therefore required to ensure that the workplace concentration limit for ozone is not exceeded. Aside from optimised natural ventilation via windows, this can, for example, be realised by installing a fume cupboard or appropriate room ventilation system.

3.3.6 Use of robots

Robots are used in a wide variety of research fields today. These range from research on the robots themselves (for example, the further development of collaborating robots) to the use of industrial robots in small-series production, for example, in material research or for material testing. Automated laboratory equipment, such as autosamplers and automatic pipetters, is increasingly used in various laboratories as well. The possible hazards, such as crushing, due to the mechanical movements generally have to be analysed. When automated systems are used with biological agents or dangerous substances, hazards posed by contaminated (hollow) needles in particular have to be avoided. Possible measures include human/machine separation, for example, using light barriers, light curtains, covers or doors with limit switches, respectively causing an automatic shut-down. This is not possible, for example, in the (further) development of collaborating robots. Other measures such as force limitation and slow movements have to be applied here.

FURTHER INFORMATION

- DGUV Information 209-074 “Industrial robots”
- FBHM 080 “Collaborating robot systems”
- DIN EN 61010-2-081 VDE 0411-2-081 “Safety requirements for electrical equipment for measurement, control and laboratory use – Part 2-081: Particular requirements for automatic and semi-automatic laboratory equipment for analysis and other purposes”

3.3.7 Working with nanomaterials

Nanomaterials are defined by their small size (from about 1 nm to about 100 nm) in conjunction with the special characteristics caused by their small size (for example, the extremely large surface in proportion to the mass, or quantum mechanical effects). In contrast to typical dangerous substances, the complex physical structure is significant for nanomaterials in addition to the composition. Nanomaterials also include composite nanomaterials and materials with a surface coating made of nanoparticles. Nanomaterials are produced or processed in the laboratory, for example, to research new fields of application.

The hazards that nanomaterials pose for people have not been fully researched yet. It is known that some nanoobjects can penetrate biological structures. While possible negative consequences are not yet (fully) known, effective protective measures are required according to the precautionary and minimisation principle. Protective measures that are also used for ultrafine dusts, gases or vapours are used here since their behaviour is comparable to that of dry nanomaterials.

Like other dangerous substances, nanomaterials can essentially enter the body in three different ways: Through inhalation as well as oral or dermal exposure. The protective measures correspond to those for the handling of other dangerous substances. For example, the inhalation hazard can be addressed with the following measures:

- Appropriate, standardised and tested laboratory fume cupboards with largely closed front panes
- Glove boxes, glove bags or other enclosed apparatuses
- Use in the wet state (for example, in suspensions or pastes)

To avoid oral and dermal exposure, gloves and gauntlets should be used that remain in the fume cupboard after use in order to minimise the contaminated zone. It is also important to ensure that the gloves and gauntlets have no openings or damage. The gloves have to protect against other chemicals that are used (for example, solvents when the nanoparticles are used as a suspension). Hygiene standards for laboratories have to be strictly observed as well.

Special care must be taken to prevent ignition sources (including electrostatic discharge): Combustible nanoobjects, in contrast to coarse-grained substances, can form an explosive atmosphere even at low concentrations and/or a low ignition energy.

Some substances (metals, for example) have a tendency to spontaneously combust when finely distributed. The reactivity can be very high and catalytic effects are possible as well.

FURTHER INFORMATION

- DGUV Information 213-021 “Nanomaterials in the workplace”
- DGUV Information 213-853 “Nanomaterials in the laboratory – handling guidelines”
- Nanorama DROM BG RCI
- TRGS 527 “Activities with nanomaterials”

3.3.8 Working with fine powders

The physical properties of many substances change depending on their grain size. In particular, metals that are not classified as dangerous substances in the coarse material form can become dangerous substances due to disintegration in the absence of air. The enlargement of the surface area can cause such metal powders to spontaneously self-ignite upon contact with oxygen. Other combustible materials may also have a spontaneous combustion tendency when finely distributed.

Dust minimisation measures are generally required when handling fine powders or for work that produces fine powders (dry grinding, for example).

If a specific workplace concentration limit (in the air) has not been defined for the dangerous substance in question according to TRGS 900, compliance with the general dust limit value according to TRGS 900 is required as a minimum for the inhalable and respirable fraction of the produced dust.

FURTHER INFORMATION
- TRGS 900 "Workplace concentration limits"
- VBG Expertise "Don't give dust a chance!"
- Dust information

3.3.9 Working with ionising radiation

Working with ionising radiation is regulated by the Radiation Protection Act (Gesetz zum Schutz vor der schädlichen Wirkung ionisierender Strahlung (StrlSchG)) and the Radiation Protection Ordinance (Verordnung zum Schutz vor der schädlichen Wirkung ionisierender Strahlung (StrlSchV)).

According to the radiation protection principles, each application of a radioactive substance or ionising radiation has to be justified. This means that the benefit (for example, the gain in knowledge) outweighs the potential damage. If the application is justified, all measures according to the best available science and technology have to be implemented to avert possible damage. The dosage limitation principle applies. Various limit values have been established according to the exposed body part, exposure duration and different groups of persons. The optimisation principle demands that the likelihood of exposure, the number of exposed persons and the individual dose per person be kept as low as possible. Four basic rules contribute to this:

1. Radiation shielding with suitable materials.
2. Limiting the duration of stay in the radiation field.
3. Maintaining a safe distance from the radiation source.
4. Using the lowest possible activity of the radiation source according to the application.

Radioactive substances have to be kept under lock and key on principle. They may only be used at the workstation in the necessary minimum quantities and at the required times. Hygiene is particularly important at these workstations to avoid incorporation. Access to these workstations has to be restricted. Pregnant women and nursing mothers are not permitted at these workstations. Young people are only allowed when this is essential to achieve the educational objective. Direct skin contact must be avoided with suitable PPE. Provisions for transportation, fume cupboards and the disposal of the substances and materials that are used apply in addition. A radiation protection representative is always required for activities subject to radiation protection law. If the radiation protection representative does not have the necessary expertise, they must appoint a radiation protection officer. Their tasks and the necessary technical qualifications are described in the StrlSchV.

Please refer to the StrlSchG and the StrlSchV for further information. Information with regard to the licensing requirements is also found here in Chapter 2.

LEGAL BASIS
- Radiation Protection Act (StrlSchG)
- Radiation Protection Ordinance (StrlSchV)

3.3.10 Electromagnetic fields

Electromagnetic fields can have a direct effect in tissue (e.g. irritant effect, heat effect) or an indirect force effect. Reactions to contact voltages and body currents are also possible in case of contact with conductive structures. Systems with powerful electromagnetic fields include induction, electrolysis and microwave equipment, overhead lines and high-power transmission equipment. Powerful electromagnetic fields can have adverse effects on people with active and passive implants in particular.

The regulations of the Occupational Safety Ordinance on Electromagnetic Fields (Verordnung zum Schutz der Beschäftigten vor Gefährdungen durch elektromagnetische Felder (EMFV)), the corresponding Technical Rules of the Occupational Safety Ordinance on Electromagnetic Fields (Technische Regel zur Arbeitsschutzverordnung zu elektromagnetischen Feldern (TREMF)), DGUV Regulation 15 "Electromagnetic fields" (DGUV Vorschrift 15 "Elektromagnetische Felder") and DGUV Rule 103-014 "Electromagnetic fields" (Elektromagnetische Felder) apply when insured persons are exposed to electrical, magnetic or electromagnetic fields. These cover the frequency range from 0 Hz to 300 GHz. Medical applications on patients are explicitly not regulated herein, while the practitioners are covered by the rule. Areas covered by the 26th ordinance for the implementation of the BImSchG are also exempt.

Areas with powerful electromagnetic fields caused, for example, by strong electromagnets or permanent magnets, have to be identified according to ASR A1.3.

Access has to be regulated and restricted accordingly. The maximum field strength values must not be exceeded in areas accessible to insured persons.

In order to ensure this, the exposure areas have to be established, the occurring electromagnetic fields must be determined and the exposure of the personnel has to be evaluated. The permissible exposure values according to the frequency range of the electromagnetic field in question are listed in the TREMF.

The effect of antennas and ferromagnetic components also has to be taken into account in the hazard assessment. Since magnetic field shielding can be very difficult and costly, the adjacent rooms in all directions also have to be examined regarding the existing field strengths. This applies especially in case of powerful magnets such as those used in NMR spectroscopy, for example. Aside from securing (locking) danger areas, measures to prevent inadmissible exposure of personnel include shielding, maintaining a safe distance, reducing the output power, shut-off, access control to limit the duration of stay and personal protective equipment. Technical measures have to be implemented first. Organisational measures and personal protective equipment are used only when they are not sufficient or not applicable. Danger areas in test facilities have to be defined and identified. A red warning light is required to show that the system is powered up. The Technical Rules also regulate the inspection and monitoring of systems, the instruction of personnel, documentation and special measures for persons with active or passive implants.
Please refer to the cited directives, regulations and rules for more information.

LEGAL BASIS

- Federal Immission Control Act
- DGUV Rule 103-014 "Electromagnetic fields"
- DGUV Regulation 15 "Electromagnetic fields"
- Occupational Safety Ordinance on Electromagnetic Fields
- Technical Rules of the Occupational Safety Ordinance on Electromagnetic Fields

FURTHER INFORMATION

ASR A1.3 "Safety and health protection labelling"

3.3.11 Working with biological agents

Working with biological agents has to be differentiated between specific and non-specific activities with biological working materials. Differentiation into four protection levels is also required for activities with biological working materials in different risk groups. Hazards for laboratory personnel must be avoided or at least minimised by establishing minimum requirements for the structural, technical, organisational and personal protective measures in laboratories. Aside from rooms where activities with biological working materials are carried out, protection levels apply for functional rooms such as brooder houses, centrifuge rooms, cold rooms or freezer rooms and rooms for the inactivation of biological working materials, insofar as activities according to Section 7 of the BioStoffV are carried out here.

According to Part 1 of the BioStoffV, biological agents are classified in one of the following risk groups according to their infection risk:

- **Risk group 1:** Biological agents that are unlikely to cause a disease in humans.
- **Risk group 2:** Biological agents that can cause a disease in humans and may pose a hazard for employees. Spread in the population is unlikely. Effective prevention or treatment is normally possible.
- **Risk group 3:** Biological agents that can cause a serious disease in humans and may pose a serious hazard for employees. There may be the risk of spread in the population, but effective prevention or treatment is normally possible.
- **Risk group 4:** Biological agents that cause a serious disease in humans and pose a serious hazard for employees. The risk of spread in the population may be high. Effective prevention or treatment is normally not possible.

Before activities with biological working materials start, institute management has to perform a hazard assessment and document the same. The support of a person with corresponding technical qualifications is required if institute management is not qualified in this field. The knowledge required for the technical qualifications depends on the type of task and severity of the hazard. Proof of the required knowledge must be provided by means of appropriate vocational training and applicable, timely work experience. Special continuing education measures may be required. In accordance with Section 4 (3) of the BioStoffV institute management has to obtain information for the hazard assessment, in particular about the identity, risk group classification, transmission routes and uptake paths of the biological working materials that are used or may be present, and about the health hazards posed by them (infectious, sensitising, toxic or other effects detrimental to health). The assignment to the required protection level and establishing the necessary protective measures are based on this, and on the activities and workflows. Assignment to the risk group is based on TRBA 460, 462, 464, 466, 468 and 450. In addition to causing infections, biological agents can, for example, also have sensitising or toxic effects. Corresponding information is found in TRBA 406, 460, 464 and 466. Appropriate measures have to be derived here as well.

Appropriate work clothing must be worn for activities in laboratories. Street clothes do not constitute appropriate work clothing. In particular, a lab coat is appropriate in accordance with the requirements of TRBA 100 or TRGS 526 in conjunction with DGUV Information 213-850 “Working safely in laboratories” (Sicheres Arbeiten in Laboratorien). Clothing contaminated with dangerous substances or biological agents (work or street clothing) has to be cleaned by the research institute TRBA 500, GefStoffV.

Hazards to third parties and the environment have to be taken into account and the various measures must be coordinated with each other. The hazard assessment has to be updated regularly, at least every two years. When significant changes are made to the work conditions, new information is available or in case of indications that the existing protective

measures are not sufficiently effective, the hazard assessment has to be updated promptly.

LEGAL BASIS
- Biological Agents Ordinance
- Hazardous Substances Ordinance
- TRBA overview "Selected TRBA"
- TRBA 100 "Protective measures for activities involving biological agents in laboratories"
- TRBA/TRGS 406 "Sensitising substances for the respiratory tract"
- TRBA 450 "Criteria for the classification of biological agents"
- TRBA 460 "Classification of fungi into risk groups"
- TRBA 464 "Classification of parasites into risk groups"
- TRBA 466 "Classification of prokaryotes (bacteria and archaea) into risk groups"
- TRBA 500 "Basic measures to be taken for activities involving biological agents"
- TRGS 526 "Laboratories"

FURTHER INFORMATION
- DGUV Information 213-086 "Biological laboratories – equipment and organisational measures"
- DGUV Information 213-850 "Working safely in laboratories"

3.3.12 Working outside the institute premises

Research often takes place outside the institute's own facilities. This ranges from research cooperation – where part of the research work is done in the cooperating institute – to sample collection, excursions or participation in events and conventions. Here the influence on the local conditions is limited. That makes it all the more important to perform a hazard assessment in advance in order to derive measures and be prepared for the conditions on site. Using the existing hazard assessment as the basis is advisable when working in a third-party institute or laboratory. Large sections are often transferable. It is important to also examine the mutual hazards of the regular employees at the respective site as well as the additional (guest) scientists, and to appoint a person as coordinator if necessary. Ergonomics in the workplace should also be considered (for example, when bringing one's own laptop).

FURTHER INFORMATION
- DGUV Information 211-040 "Use of mobile information and communication technology in the workplace"
- DGUV Information 211-006 "Protection of health and safety through coordination"
- DGUV Information 215-830 "Cooperation between companies under contracts for work and labour"

Working outdoors

Many branches of research include outdoor activities, for example, in the course of field tests, for measurements, sample collection or mapping. Here it is important to prepare a hazard assessment in advance and to compare this to the conditions on site.

Health and accident hazards can be cause, for example, by:

- Precipitation (rain, snow, hail)
- High winds
- Sunlight
- Heat and cold
- High relative humidity (for example, when working in tropical regions)
- Ice and packed snow
- Lightning strike during thunderstorms
- Unpaved and uneven roads and surfaces
- Falling when working at heights
- Drowning or sinking in (running) bodies of water or surfaces with insufficient load bearing capacity (bog, sand and the like)
- Animals

Appropriate measures to counteract the associated hazards, such as special equipment, are required and must be established in a corresponding hazard assessment. Voluntary or compulsory preventive care according to the ArbMedVV may be required in addition. This applies to activities subject to special climate stresses, activities in sunlight or special infection hazards due to animals (for example, ticks, mice or bats), among others.

FURTHER INFORMATION
Chapter 3.4 Personal protective equipment

Activities abroad

Research projects often lead abroad for participation in conferences, conventions or workshops, excursions or project meetings. Here the work conditions are highly dependent on local factors. Aside from a different language and culture group, the climate and associated infection hazards may also differ. In addition, activities different from those in the own research institute are carried out, especially during excursions (for example, mountain climbing or hiking with luggage, diving). The necessary health and safety measures therefore have to be clarified in advance by means of a hazard assessment for events abroad.

In particular, the following must be clarified:

- The insurance situation – in case of illness and accidents, for example – and whether additional insurance is needed. Corresponding insurance has to be obtained
- The typical national legal situation regarding occupational safety regulations and liability
- How to ensure compliance with the applicable national and German occupational safety provisions.
- Additional measures have to be implemented as needed
- Occupational health advice for all participants before the start of the trip
  - Whether preventive occupational medicine is required before and after the trip, for example, in case of deployment in the tropics/subtropics or time spent abroad under special climate conditions and infection hazards
  - Whether vaccinations are required and how international rescue services and outpatient/inpatient treatment options on site are organised; whether medical equipment and additional first aid materials must be brought along
  - Whether special clothing, special protective equipment, disinfectants or water treatment are required due to geological, climate and hygiene conditions or activities at the deployment location
- What the technical conditions are and what necessary work equipment must be taken along – for example, electrical cables, PRCD, isolating transformers
- Whether special safety measures are required, for example, PPE
- Whether special social and cultural conditions exist in the country of deployment that must be considered to work undisturbed and as considerately as possible

- What the security and dangerous situation is on site (for example, war, uprisings and crime). If necessary, organise a local guide or driver, for example
- What the communication options are – for example, Internet, telephone networks, satellite telephone, search transmitter
- Where diplomatic and consular representations, translators and legal counsel can be accessed

If necessary, include a local contact or support person who is familiar with the special cultural and climate conditions on site, and knows the terrain and the necessary skills and equipment. If special skills (diving) or equipment are needed, the participants must have sufficient qualifications and experience, and need to be involved (especially) early on. The equipment must be inspected for suitability and good condition by competent persons. Safety measures and rescue operations have to be planned and practised. The hazard assessment prepared before the start of the trip has to be compared to the actual conditions on site.

Current influences, such as the weather, have to be considered.

Insurance coverage abroad
Employees are covered by German statutory accident insurance, even abroad, when they are temporarily deployed under a domestic employment relationship.

For this, the following conditions have to be met:

- The stay abroad for work purposes is of limited duration for the employee from the outset
- The domestic employment relationship is not interrupted during the deployment. The employee continues to be paid by and subject to the directives of the employer
- Employees initially hired for work abroad must continue their employment relationship with the domestic employer after the end of the stay abroad

However, this does not apply for longer stays abroad of unlimited duration or for employees hired exclusively for working abroad. Note that private (recreational) activities are generally not covered by statutory accident insurance, also abroad. This applies correspondingly to illnesses due to inner causes (circulatory or gastrointestinal diseases). Corresponding instruction of the employees is required.

FURTHER INFORMATION

- BGHM Handout "Occupational health and safety during foreign assignments"
- DGUV "Statutory accident insurance for deployment abroad"
- DGUV "Insurance protection for employment abroad – tips and information"
- DGUV Regel 101-023 "Deployment of research divers"
- DGUV Recommendations for occupational health consultations and examinations
- UK NRW: S25 "Health and safety for archaeological excavations"
- VBG "Checklist for Companies: Work Deployment Abroad"
- VBG "Insurance protection abroad"

3.4 Personal protective equipment

Technical and organisational measures that exclude hazards for employees take precedence over the use of personal protective equipment (PPE) on principle.

When these possibilities have been exhausted, institute management has to provide appropriate personal protective equipment in sufficient quantities to reduce the residual risk for work where injuries or the impairment of health cannot be excluded.

The use of personal protective equipment is derived from the specific hazard (hazard assessment) – examples:

- Hard hats wherever head injuries due to falling objects or impacts on obstacles cannot be excluded – for example, when work is performed simultaneously on multiple levels
- Protective footwear wherever foot injuries are possible – for example, during setup, removal or conversion work, in workshops, for work in storage and transportation, or when there is a possibility of stepping on pointy or sharp-edged wood, glass or metal parts
- Protective footwear with electrostatic discharged (ESD) – for example, when working with potentially explosive substances
- Cut or puncture-resistant protective gloves or special chemical protection gloves for all work where hand injuries are possible – for example, when handling skin damaging, splintering, sharp-edged or corrosive materials, working with animals
- Personal protective equipment against falling for all work with a risk of falling – for example, working on roofs or embankments
- Eye protection (safety goggles, face shield) when eye damage is possible – for example, due to chips, slivers, dusts, corrosive substances, liquids and UV radiation (natural and artificial)
- Breathing protection when substances that are harmful to health can be inhaled – for example, in the presence of harmful aerosols, vapours or gases and during activities with impregnating agents, solvents, refrigerants, paint, adhesives or dusts
- Hearing protection for all work with noise hazards
- Skin protection to protect against UV radiation while working outdoors or for activities in workshops. Skin protection includes appropriate products for skin protection, cleaning and care
- Personal protective equipment to prevent drowning in the form of life vests for all activities with a risk of falling into water – for example, on the deck of water craft and floating equipment, when there is no railing with a height of at least one metre, on quaysides, docks or hydraulic structures Even when railings are present, life vests also have to be worn under the following conditions:
- Reduced visibility, ice drift, frost, flooding, storms, at night
- Reflective clothing or safety vest at all times in vehicular traffic danger areas

- Weather protection clothing when the work conditions pose a health hazard, for example, due to wet or cold conditions or wind

When a combination of various personal protective equipment has to be worn due to the variety of hazards, a possible mutual reduction of the protective effect has to be avoided. For example, when ear muffs and safety goggles are worn at the same time, the protective effect of the ear muffs is often reduced considerably unless models explicitly suited for this are selected. Personnel must use the PPE provided and maintain its functionality. The responsible person on site has to verify the proper use of the personal protective equipment.

When PPE against fatal hazards (for example, falling or drowning) or PPE to protect against permanent impairments of health (for example, hearing protection) is provided and used, information for its use has to be provided to the employees concerned in the course of instruction.

LEGAL BASIS

- DGUV Rule 112-989 "Use of protective clothing"
- DGUV Rule 112-194 "Use of hearing protection"
- DGUV Rule 112-198 "Use of personal protective equipment against falling"
- DGUV Rule 112-199 "Rescue from heights and depths with personal fall protection equipment"

Selection of suitable protective gloves

Especially in research, dangerous substances that damage the skin or can be absorbed through it often cannot be substituted entirely or used in enclosed systems. Corresponding, suitable personal protective gloves are required to avoid hazards due to skin contact. Here the protective effect depends on the glove material, thickness of the material, the dangerous substance being used and the type of use. Not every material protects against all dangerous substances. In addition, certain makes of gloves only provide protection against skin contact with the dangerous substance for the time specified by the glove manufacturer (penetration time). Depending on the dangerous substance, the penetration time may be very short. This means that the glove has to be changed immediately after contact with the dangerous substance and contaminated gloves require corresponding proper disposal. Since a very large number of different dangerous substances may occur in research institutes in particular, corresponding protective gloves also have to be provided for all dangerous substances that are used. Employees must be instructed in their proper selection and use.

The selection of suitable protective gloves is based primarily on the information in the safety data sheet for the dangerous substance. A flowchart for selecting the suitable gloves based on this information is provided in Attachment 8 of TRGS 401 "Risks resulting from skin contact" (Gefährdung durch Hautkontakt). The glove database of the Employer's Liability Insurance Association for the Construction Industry (BG BAU) and the Practice guide "Which gloves do I use?" (Welcher Handschuh ist der Richtige) of the IFA (Institut für Arbeitsschutz) provide further selection support. When skin protection, cleaning and care products are provided at the same time, possible interactions with the glove material must be noted in the course of selecting the skin products. Any such interactions have to be pointed out during instruction. The penetration times specified by the manufacturer apply under the environmental conditions specified in the course of standardisation. The actual protection effect may deviate under different conditions.

FURTHER INFORMATION

- Practice guide "Which gloves do I use?"
- TRGS 401 "Risks resulting from skin contact"
- WINGIS Online "Glove database"

3.5 Mental stress

Mental stress means the entirety of all ascertainable influences acting on a person from the outside that have a mental effect. In this respect, mental stress is primarily a neutral term. Depending on the type and characteristics of the stress and the individual condition of employees, the resulting impact can be positive or negative. In concrete terms this means, for example, that a technically demanding task constitutes an exciting challenge for a scientist with work experience and good problem-solving skills, from which they can learn a great deal and that also motivates them in the long term. For a scientist with no work experience, on the other hand, the same task may constitute an excessive burden they are unable to handle (on their own). This can lead to frustration, brooding after work, sleep disturbances and other problems in the short term. Especially when such a situation continues over the longer term and is paired with other potentially hampering stress factors (see below), long-term negative health consequences can definitely develop (for example, burnout, depression or psychosomatic complaints). Individual development opportunities or concerns regarding excessive demands should thus be considered by managers in the distribution of tasks.

Taking mental stress into account in the hazard assessment is therefore binding for employers.

Systematically recording mental stress in the course of the hazard assessment helps managers in the research institute identify potential hazards as early as possible and take corrective action. For example, starting points for the improvement of internal processes, internal communication and therefore the smooth realisation of projects can be found. Systematically deriving appropriate measures and implementing them can have a lasting, positive influence on the work conditions, working atmosphere and employee loyalty.

Regardless of the concrete activity and sector, the following stress factors and work factors have a significant influence on the health of personnel:

- Work intensity
- Hours of work
- Scope of action and social relationships, especially with supervisors
- Work environment and conditions, especially stress due to noise

Therefore, they should be considered in the hazard assessment on principle.

Stress factors that are specific to working in the field of research should be included as well. Due to the peculiarity of research institutes, especially regarding the modes of working, work tasks and content but also regarding the composition of personnel, employees in research institutes can be exposed to a wide variety of mental stress factors. Some of these are cited here as examples:

- Existential uncertainty when the job depends on the success of a project application and for work under fixed-term contracts
- Ongoing high time and performance pressure in project work and when preparing project applications and publications – maintaining or obtaining excellence status
- Excessive demands placed on scientists by themselves or self-endangering behaviour, including exceeding the permissible working times and taking less than the required breaks
- Effort-reward imbalance (gratification crisis): Disparity between employee engagement and the recognition of performance (for example, monetary or by other persons, in particular supervisors)
- Excessive technical or methodology demands, in particular for young scientists with little experience – communication of research results (during conferences, for example) and project work as well as publication in a foreign language
- Failures in research work – communication of failures and dealing with this personally
- Working with materials with unknown properties or previously unexplored effects on human health; working with known dangerous processes or substances
- High employee turnover on all levels of the hierarchy
- Social conflicts with other employees (for example, in the course of interdisciplinary and intercultural collaboration) and supervisors (for example, dependency with regard to continued employment and/or the evaluation of research work)
- Competing or unclear task distribution and responsibilities – including differentiation between research assignments of various researchers, differentiation between different roles (for example, laboratory management, project management and the like)
- Frequent changes in the work conditions due to new projects, new facilities, changed research direction
- Ethical-moral conflicts with regard to the own research (for example, content, implementation or handling of results)
- Criticism of the own research by third parties or society, including threats

The approach to the hazard assessment for mental stress factors, suitable methods and possible design approaches are described among others in the VBG Expertise “Hazard assessment for mental stress factors” (Gefährdungsbeurteilung psychischer Belastung). The VBG also offers information and support for conducting workshops (“KiT – brief analysis as a team” (Kurzanalyse im Team)) and provides an online tool for recording mental stress factors.

FURTHER INFORMATION

- VBG Expertise “Hazard assessment for mental stress factors”
- Online tool of the VBG for recording mental stress factors
- KiT – brief analysis as a team
- DIN EN ISO 10075 “Ergonomic principles related to mental workload”

4 Overview of specialists and persons in charge at research institutes

This section provides an overview of specialists and persons in charge of health and safety. It briefly presents the legal obligations of companies to designate persons in charge, given the existence of the corresponding departments, facilities, persons or work equipment.

The specialists and persons in charge are listed in alphabetical order with references to the legal requirements for their appointment:

English	German	References
Animal welfare officer	**Tierschutz-beauftragte**	Protection of Animals Act (TierSchG) General Administrative Regulation (AVV)
Biological safety officer	**Beauftragte für bio-logische Sicherheit**	Genetic Engineering Act (GenTG) Genetic Engineering Safety Ordinance (GenTSV) Biological Agents Ordinance (BioStoffV)
CE officer	**CE-Beauftragte**	Machinery Ordinance for machinery and equipment
Company doctor	**Betriebsärztinnen und Betriebsärzte**	Occupational Safety Act (ASiG) DGUV Regulation 2 of the Employers' Liability Insurance Associations (BG)
Dangerous goods officer	**Gefahrgut-beauftragte**	Section 3(1), no. 14 of the Dangerous Goods Transportation Act (GGBefG) in conjunction with Section 3 of the Dangerous Goods Officer Ordinance (GbV)
Data protection officer	**Datenschutz-beauftragte**	General Data Protection Regulation (GDPR)

English	German	References
Electrically skilled person	**Elektrofachkräfte**	DIN VDE 1000-10
Emission protection officer	**Immissionsschutz-beauftragte**	Section 7(2) of the 5th Federal Emission Protection Ordinance (BImSchV)
Environmental officer	**Umweltbeauftragte**	Section 53 of the BImSchV
Evacuation helper	**Evakuierungs-helferinnen und Evakuierungshelfer**	Section 10 of the Occupational Health and Safety (ArbSchG)
Evacuation officer	**Evakuierungs-beauftragte (EVB)**	Section 25(4) of the Occupational Health and Safety Act Construction Worker Protection Ordinance (BauV)
Fire safety helper	**Brandschutz-helferinnen und Brandschutzhelfer**	Section 10 of the ArbSchG and DGUV Regulation 1
Fire safety officer	**Brandschutz-beauftragte**	Section 10(2) of the ArbSchG
First-aid helper	**Ersthelferinnen und Ersthelfer**	ArbSchG and DGUV Regulation 1
Hazardous substances officer	**Gefahrstoff-beauftragte**	Section 6 of the Hazardous Substances Ordinance (GefStoffV)
Health and safety officer	**Fachkräfte für Arbeitssicherheit**	Occupational Safety Act DGUV Regulation 2
Incident officer	**Störfallbeauftragte**	Section 58a(1) of the BImSchV for facilities that require approval
Inclusion officer	**Inklusions-beauftragte**	Section 181 of the Social Security Code (SGB) IX
Laser protection officer	**Laserschutz-beauftragte**	Section 5 of the Occupational Safety Ordinance on Artificial Optical Radiation (OStrV)
Management representative	**Beauftragte der Leitung)**	DIN ISO 9000 ff.
Occupational safety systems officer	**Beauftragte für Arbeitsschutz-systeme**	Required for operations with voluntary certification according to OHRIS (Occupational Health and Risk Management)
Quality management officer (QMO)	**Qualitäts-beauftragter (QMB)**	DIN EN ISO 9001

English	German	References
Radiation protection officer	**Strahlenschutz-beauftragte**	Section 43 of the Radiation Protection Ordinance (StrlSchV) Appointment by the radiation protection representative
Representative for employees with disabilities	**Schwerbehinderten-beauftragte (SBV)**	Section 177 ff. of the SGB IX
Safety representative	**Sicherheitsbeauf-tragte (SiBe)**	Section 22 of the SGB VII
Safety specialist	**Sicherheits-fachkräfte**	ASiG DGUV Regulation 2 of the BG
Waste officer	**Abfallbeauftragte**	Sections 59 and 60 of the Closed Substance Cycle Waste Management Act (KrWG) Waste Officer Ordinance (AbfBeauftrV)
Water protection officer	**Gewässerschutz-beauftragte**	Sections 64–66 of the Water Resources Act (WHG)

5 Overview of abbreviations

Abbreviation	German	English
AMS	Arbeitsschutz mit System	Systematic Health and Safety
ArbMedVV	Verordnung zur arbeitsmedizinischen Vorsorge	Ordinance on Preventive Occupational Health Care
ArbSchG	Arbeitsschutzgesetz	Occupational Health and Safety Act
ArbStättV	Arbeitsstättenverordnung	Workplace Ordinance
ASiG	Arbeitssicherheitsgesetz	Occupational Safety Act
ASR	Technische Regeln für Arbeitsstätten	Technical Rules for Workplaces
AVV	Allgemeine Verwaltungsvorschrift	General Administrative Regulation
BAuA	Bundesanstalt für Arbeitsschutz und Arbeitsmedizin	Federal Institute for Occupational Safety and Health
BetrSichV	Betriebssicherheitsverordnung	Industrial Safety Directive
BG	Berufsgenossenschaft	Employer's Liability Insurance Association
BG BAU	Berufsgenossenschaft der Bauwirtschaft	Employer's Liability Insurance Association for the Construction Industry
BImschG	Bundes-Immissionsschutzgesetz	Federal Immission Control Act
BImSchV	Bundesimmissionsschutzverordnung	Federal Emission Protection Ordinance
BioStoffV	Verordnung über Sicherheit und Gesundheitsschutz bei Tätigkeiten mit Biologischen Arbeitsstoffen (Biostoffverordnung)	Biological Agents Ordinance
CLP	Einstufung, Kennzeichnung und Verpackung	Classification, labelling and packaging
dB(A)	A-bewerteter Schalldruckpegel in Dezibel	A-weighted sound pressure level in decibels
dB(C)	C-bewerteter Schalldruckpegel in Dezibel	C-weighted sound pressure level in decibels
DGUV	Deutsche Gesetzliche Unfallversicherung	German Social Accident Insurance
EMFV	Verordnung zum Schutz der Beschäftigten vor Gefährdungen durch elektromagnetische Felder	Occupational Safety Ordinance on Electromagnetic Fields
GefStoffV	Verordnung zum Schutz vor Gefahrstoffen	Hazardous Substances Ordinance
GenTSV	Gentechnik-Sicherheitsverordnung	Genetic Engineering Safety Ordinance
HVAC	RLT (raumlufttechnisch)	Heating, Ventilation, Air Conditioning
IFA	Institut für Arbeitsschutz	Institute for Occupational Safety
IfSG	Infektionsschutzgesetz	Infection Protection Act
LärmVibrations-ArbSchV	Verordnung zum Schutz der Beschäftigten vor Gefährdungen durch Lärm und Vibrationen	Occupational Safety Directive on Noise and Vibrations
§	Paragraph	German symbol for paragraph
PSA	Persönliche Schutzausrüstung	Personal Protective Equipment (PPE)
PSA-BV	Verordnung über Sicherheit und Gesundheitsschutz bei der Benutzung persönlicher Schutzausrüstungen bei der Arbeit	Regulation on Safety and Health Protection for the Use of Personal Protective Equipment at Work

Abbreviation	German	English
SGB	Sozialgesetzbuch	Social Security Code
SiB	Sicherheitsbeauftragter	Safety Representative
StrlSchG	Strahlenschutzgesetz	Radiation Protection Act
StrlSchV	Strahlenschutzverordnung	Radiation Protection Ordinance
TA Lärm	Technische Anleitung zum Schutz gegen Lärm	Technical instruction on protection against noise
TRBA	Technische Regeln für biologische Arbeitsstoffe	Technical Rules for Biological Agents
TRBS	Technische Regeln für Betriebssicherheit	Technical Rules for operational Safety
TREMF	Technische Regel zur Arbeitsschutz-verordnung zu elektromagneti-schen Feldern	Technical Rules of the Occupational Safety Ordinance on Electromagnetic Fields
TRGS	Technische Regeln für Gefahrstoffe	Technical Rules for Hazardous Substances
TRLV Lärm	Technische Regel zur Lärm- und Vibrations-Arbeitsschutzverord-nung	Technical Rules of the Occupational Safety Ordinance on Noise and Vibration
TROS	Technische Regeln zur Arbeits-schutzverordnung zu künstlicher optischer Strahlung	Technical Rules of the Occupational Safety Ordinance on Artificial Optical Radiation
UK NRW	Unfallkasse Nordrhein-Westfalen	Accident Insurance North Rhine-Westphalia
UV	Ultraviolett	Ultraviolet
VBG	Verwaltungs-Berufsgenossenschaft	Statutory accident insurance provider

Further explanations, regulations and rules/standards are available on the Internet at regelwerke.vbg.de.

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