Fachbereich AKTUELL

FBHM-016

DGUV
Fachbereich Holz und Metall
Berufsgenossenschaft
Holz und Metall

Sachgebiet Maschinen, Robotik und Fertigungsautomation

Trial operation
of machines and assemblies of machinery

Stand: 09.08.2019

Translation of the German version.

This “Fachbereich AKTUELL” deals in particular with problems arising in conjunction with the trial operation of machines and assemblies of machinery carried out by the manufacturer. The trial operation involves higher accident and health risks than machines and assemblies of machinery operated in normal operation. This is for example due to the fact that tasks have to be carried out within assembly areas which are usually not entered or that safeguards are not yet effective to enable the execution of special tasks at all.

Existing rules and regulations do not define any details concerning trial operation. This “Fachbereich AKTUELL” is therefore intended to provide an overview of protective measures for trial operation to responsible persons. It considers current legal provisions and should support a safe execution of the trial operation as a general guideline. This does not only contribute to occupational safety and health but also to economic targets such as the avoidance of machine damages and delays.

Figure 1: Example of a warning sign

1 Definition

The trial operation of machines and assemblies of machinery is intended to check functions and characteristics and to detect and eliminate faults. The trial operation corresponds to the final test stage of a machine or an assembly of machinery and is therefore subject to the manufacturer’s responsibility, even if executed at the user‘s premises.

> Since assemblies of machinery usually involve several manufacturers of individual assembly components, the term **manufacturer** describes the party that is acting as main contractor or as manufacturer of the whole assembly.

At first, test runs of the individual units and devices are carried out, if possible. If these fulfill their specifications, the whole assembly of machinery is tested. The conditions and characteristic values determined by the trial operation, can be compared with the intended characteristics. On that basis, modifications and optimizations can be carried out in order to achieve the targets.

For trial operation, protective measures as those required for normal operation cannot yet be fully taken. For the scope of this “Fachbereich AKTUELL”, the term „trial operation“ is understood to be the operation which is still subject to the

Table of Contents

manufacturer's responsibility as long as the assembly of machinery has not been transferred to the user. Test runs carried out by the user after modifications, reconstructions, repair and maintenance work and the like, i. e. between phases of normal operation, are not dealt with., The procedure and possible protective measures can, however be applied analogously (see DGUV Information 209-066 (previously: BGI 5003) „Maschinen der Zerspanung" clause 2.4 [1]).

2 Legal situation

As part of the manufacturing process, the trial operation is carried out before the time of placing on the market. The required adjustments can thus be made without the machine having to comply with the European Machinery Directive [2]. But nevertheless, other protective measures have to be taken.

Trial operation must not be confused with **putting into service** by the user:

Putting into service means the first use of a machine or product by the end user in the European Economic Area.

Therefore, machines and assemblies of machinery have to fulfill all applicable directives already at the time of putting into service! Though the European Machinery Directive specifies essential health and safety requirements for machinery, it does not contain any regulations on trial operation. The Produktsicherheitsgesetz (ProdSG) [3] (German Product Safety Act) cannot be applied either, as it covers the placing on the market of products. The trial operation, however, is carried out prior to the time of delivery to the user which means that the machine or the assembly of machinery is not placed on the market at that time. Nevertheless, during trial operation, the provisions specified in the Accident Prevention Regulation DGUV Regulation 1 „Principles of prevention" [4] in conjunction with the Arbeitsschutzgesetz (ArbSchG) (German Industrial Safety Act) [5] and the Betriebs-sicherheitsverordnung (BetrSichV) (Ordinance on Industrial Safety and Health) [6] have to be complied with.

These include in particular the duties of entrepreneurs (here the manufacturer responsible for the trial operation), such as e. g. assessment of working conditions, measures to prevent accidents at work and giving instructions (see DGUV regulation 1, second chapter).

The duties of the insured (here the employees involved in the trial operation) include safety-related behavior, use of safeguards and compliance with unauthorized access provisions (see DGUV regulation 1, third chapter).

3 Particular hazards during trial operation

The personnel involved in the trial operation of the machine or assembly of machinery is exposed to a higher risk due to particular hazards than during normal operation. The increased risk results from the usually higher workload of the personnel (unexpected problems, time pressure, fatigue, noise, unfavorable climatic conditions, difficult communication), the mutual hazard, as different groups often have to work at the same time, and possibly imperfect technology and ineffective or inappropriate safeguards. In addition, the risk of an unexpected start-up of machine parts is frequently not considered which involves a high risk of accident.

4 Measures for safe trial operation

Basically, the occupational health and safety measures for normal operation should have already been taken for trial operation as far as possible. However, this can usually not be implemented because the assembly of machinery is still being mounted and incomplete and assembly works have not been completed. Therefore, a safety concept must be developed on the basis of a risk assessment in accordance with the ArbSchG (German Industrial Safety Act), which includes further protective measures in addition to the safeguards which are already effective.

The general procedure for determining protective measures for trial operation is shown by a flow diagram in Annex 1 on page 8.

4.1 Clarifying responsibility

Questions of responsibility and competences of companies and employees involved in trial operation should be clearly defined in writing. Usually, the assembly of machinery is the responsibility of the manufacturer or general contractor during assembly and trial operation. This also applies for the period of time while it is being installed at the user's plant.

Only at an agreed handover date, the assembly of machinery is the responsibility of the user (operational handover).

4.2 Appoint leader of trial operation

A responsible leader should be designated for the trial operation, as well as a deputy for longer trial periods. The trial operation leader should be capable of handling the tasks assigned to him / her based on his/her qualification and experience and he/she should be authorized to give instructions. This requires in particular precise knowledge of the interaction of the individual assembly components.

4.2.1 Tasks

The leader of the trial operation should be assigned the following tasks:

- determination of the trial operation process
- assessment of hazards and risks
- determination of hazardous areas and their marking
- determination of the protective measures and checking the effectiveness
- instructing and assigning employees
- ensuring first aid and rescue routes
- determination of control permissions
- he/she has to be permanently available and known to all employees
- verification of the employees‘ qualifications (including language skills)

For larger projects, additional persons should be appointed who are responsible for specific areas in order to relieve and support the leader of the trial operation. Furthermore, there should be the possibility to support the trial operation leader in special activities by skilled personnel, for example when assessing hazards.

On construction sites, it frequently occurs that parts of an assembly of machinery are already undergoing a trial operation, while other parts are still being mounted. Moreover, several companies are usually working at the same time. Therefore, trial operation should only be carried out in close coordination between the leader of the trial operation and the site supervisors or the person responsible for the coordination (see also DGUV Information 211-006 (previously: BGI 528). „Sicherheit und Gesundheitsschutz durch Koordinieren“ [7]).

4.2.2 Planning the process and assessing the hazards

The responsible leader of the trial operation must at first plan the trial operation procedure and, if necessary with the support of other specialists, assess the risks and hazards. In order to minimize hazards, the order of activities, working procedures and protective measures should be specified. When assessing hazards, it may be appropriate to prepare a task-related assessment. According to ArbSchG, it is sufficient to assess one workplace or one activity if working conditions are similar.

The safety instructions of the manufacturers of supplied machine and assembly parts may also need to be considered. When planning the procedure, all tests of the assembly of machinery that precede the trial operation should be taken into account, such as stability, power connections, operational readiness of safety equipment, correct function of the control logic of drives, protective measures against electric shock. All applicable protective measures must already be effective during the first test runs. This includes in particular safeguards, such as e.g. emergency stop devices or, in case of electrical hazards, emergency switch off devices.

> In the following, the term "**emergency switch off**" is used in a generalized way for both devices, i.e. shut down in an emergency in case of dangerous movements (emergency stop) and switch off in an emergency in the event of electrical hazards (emergency switch off) (see DIN EN 60204-1 Annex E [8]).

Safeguards that are not yet functioning should be covered or marked ("out of service"), so that they can not be confused with already effective devices. Information on the determination of hazards can be found in the documentation of purchased assembly parts. More general hazard catalogs that can serve as checklists are contained in DIN EN ISO 12100 [9].

Based on the risk assessment, the need for action can be identified and protective measures can be defined. It also provides a good basis for instructing employees (see Annex 2 on page 9).

4.2.3 Determination and marking of danger zones

When determining the danger zones, the cases "expected operation" and "fault" should be

considered. Breakage or the ejection of machine or workpiece parts may necessitate an enlargement of the danger zones to be restricted and further protective measures.

Figure 2: Use of flexible fences

The entire area around the assembly of machinery running in trial operation should be protected against access by unauthorized persons. Access must only be granted with the assembly at a standstill by the person responsible for the respective area. Warning signs indicating the name of the responsible person (name and telephone number) are to be attached to possible access routes to the danger zone. In addition, areas of an assembly of machinery which are still being mounted have to be clearly separated from areas that are already running in trial operation.

The danger zones of the assembly, in which only authorized and instructed persons are allowed to stand even at standstill, have to be marked. In practice, e. g. the use of flexible fences has proven to be useful (see Fig. 2). A pure marking instead of a guard is permissible here, as long as the assigned and instructed employees of the trial operation have access only.

If the assembly of machinery to be tested is located on a construction site where the presence of third-party or operator personnel has to be expected, the danger zones should in any case be safeguarded by stable, possibly anchored, mesh fences and interlocked access doors.

The authorized leader of the trial operation must ensure that no person stays longer or more often in the danger zone than absolutely necessary. Works that can be done at standstill must never be carried out while the assembly is running. It must even not be tolerated that employees "act only just quickly" in the hazardous area without protective measures. Likewise, supervisors should set a good example to influence the behavior of workers by applying the protective measures as well and, for example, have their access approved by the leader of the trial operation or the area manager.

4.2.4 Give instructions

See Annex 2 on page 9.

4.2.5 Take protective measures

Basically, work on running machines or assemblies of machinery should only be carried out if absolutely necessary. In this case, further protective measures must be provided.

Unprotected assembly components must only be tested if all dangerous processes are within the personnel’s field of vision. The visual contact can be made for example via mirrors or cameras.

Protective films on polycarbonate protective screens on machines are usually non-transparent and are often removed just before putting into service. As a result, hazards can arise during the trial operation due to the lack of visibility into the danger zone. Therefore, protective films should be removed before the trial runs. Otherwise, the design of the trial operation must take into account the non-visible areas by other suitable measures.

The initiation of hazardous movements must not be carried out solely on the basis of a temporal agreement.

4.2.5.1 Technical protective measures

Technical protective measures for safeguarding the trial operation include:

- Use of safe control systems with well-tried circuit techniques and components
- Switch off avoidable movements safely
- All emergency switch off circuits are ready for operation
- Reduced speeds (e.g. 250 mm / s without crushing or shearing hazard, 33 mm / s in case of crushing and shearing hazard)
- Reduced drive energy (as far as possible)
- Control of hazardous movements only via teach pendant with enabling switch, emergency switch off, hold-to run control. Required connecting sockets must be provided by design.

As a further protective measure, the employment of safety personnel outside the restricted area may be useful, for example, when working at a

particularly high risk of accident. This safety guard is also provided with an enabling switch and an emergency switch off device, watches the colleague and can also intervene.

In advanced stages of trial operation, it may be necessary to run trial runs at full working speed. This often requires close monitoring of the work process. This is not entirely possible from locations outside the restricted area and requires the presence within the assembly. Persons who have to carry out this observation task must only stay in protected areas within the restricted area. In addition, a position fixing hold-to run control device should be used together with an emergency switch off device arranged in such a way that employees cannot be exposed to hazards.

Figure 3: Assembly of machinery in trial operation with partly erected protective fence; emergency switch off circuits and visual warning devices are already operational

4.2.5.2 Further measures

Prior to test runs which are associated with hazardous movements, the responses of drives to control inputs should first be tested separately in order to detect any potentially dangerous errors in the drive logic (if possible and unless already done by the supplier).

Due to "special hazards" during the execution of the trial operation, the employees involved must receive appropriate instructions in accordance with the ArbSchG (German Occupational Health and Safety at Work Act). Appropriate work instructions should therefore be drawn up and instructions should be given.

When working in confined spaces within the machine or assembly of machinery, health and safety measures according to DGUV Rule 113-004 (previously: BGR 117-1) [10] must be observed.

The responsibilities of assembly workers and workers involved in trial operation should be clearly separated.

The hazards of the subsequent trial operation can already be reduced during design. To this effect, as many assembly parts as possible to be accessed during the trial operation should be placed outside the fenced area. These include for example control cabinets, fuse boxes, auxiliary units such as compressors, controls, fittings, display devices, storage containers for raw materials and supplies.

Figure 4: Control station with video surveillance

It should also be examined to what extent special operating modes can be set up which allow trial operation without bypassing safeguards. Furthermore, possibilities of remote diagnostics should be provided for faults and errors (fault memory, sensors, video surveillance, interfaces to the Internet and thus to the manufacturer) which aim at reducing access to the hazard zone during trial operation and normal operation as far as possible and to prevent bypassing.

It is furthermore advisable to work with the same team for the trial operation on the construction site as that employed in the manufacturer's works.

In particular, time pressure and hectic work often prompt employees to suspend safeguards or bypass safety regulations. These reactions are known and predictable. Supervisors should therefore make it clear through their leadership behavior that the safety of employees has priority over possible default periods. Thus, the

acceptance of necessary protective measures during the trial operation can be increased.

5 Overview of measures

The trial operation of machines and assemblies of machinery is associated with particular hazards and higher risks than normal operation. Special tasks must be carried out in hazardous areas which are not accessible during the normal production process. In addition, safeguards are not yet or only partially effective. However, the requirements of the DGUV regulation 1 in conjunction with the Occupational Health and Safety at Work Act and the Industrial Safety Ordinance must be taken into account even for trial operation. Therefore, a safety concept should be developed on the basis of a risk assessment which contains further protective measures in addition to those safeguards which are already effective. A designated, responsible leader should plan the sequence of the trial operation and the personnel required and monitor compliance with the protective measures he/she has defined.

To ensure safety, the following measures should generally be taken:

- name responsible leader of trial operation
- work on running machines or assemblies of machinery only if absolutely necessary
- emergency switch off circuits operational
- safeguards operational as far as possible
- reduced speeds, otherwise protected areas with position fixing
- switch off avoidable movements safely
- portable teach pendant with enabling device, hold-to run control device and emergency switch off
- mark hazard areas; attach warning signs with the name and telephone number of the responsible person
- on construction sites: safeguard access to hazardous areas by means of fixed fences; interlock access doors
- prior to test run with hazardous movements: test control logic and drive motors separately
- prepare work instructions; clear separation of assembly - trial operation
- provide instructions to the employees involved in the trial operation
- ensure first aid and rescue routes

Furthermore, hazards due to trial operation have to be taken into account already during design.

6 Summary and limits of application

This “Fachbereich Aktuell” is based on expert knowledge and findings from accidents gathered by the expert committee woodworking and metalworking, subcommittee machinery, robotics and automation of DGUV.

It should serve the responsible persons as a guide and provide an overview of measures for a safe trial operation.

The provisions according to individual laws and regulations remain unaffected by this DGUV information. The requirements of the legal regulations apply unrestrictedly.

In order to get complete information, it is necessary to consult all applicable regulation contents.

The expert committee woodworking and metalworking is composed of representatives of the German Social Accident Insurance Institutions, federal authorities, social partners, manufacturers and users.

This “Fachbereich Aktuell” replaces the version of the same title issued as DGUV Information, issue 09/2016. An updating has become necessary due to editorial changes. This is the English translation of the German issue “FBHM-016” of 09.08.2019.

Further “Fachbereich Aktuell” or information sheets of the expert committee woodworking and metalworking (Fachbereich Holz und Metall) are available for download on the internet [11].

German bibliography:

[1] DGUV Information 209-066 „Maschinen der Zerspanung“; (bisher: BGI 5003), Berufsgenossenschaft Holz und Metall, Ausgabe 2012-11

[2] RICHTLINIE 2006/42/EG DES EUROPÄISCHEN PARLAMENTS UND DES RATES vom 17. Mai 2006 über Maschinen und zur Änderung der Richtlinie 95/16/EG (Neufassung) - Amtsblatt der Europäischen Union L 157/24 (Maschinenrichtlinie)

[3] Gesetz über die Bereitstellung von Produkten auf dem Markt (Produktsicherheitsgesetz - ProdSG) vom 8. November 2011 (BGBl. I S. 2178, 2179; 2012 I S. 131), zuletzt durch Artikel 435 der Verordnung vom 31. August 2015 (BGBl. I S. 1474) geändert

[4] DGUV Vorschrift 1 Grundsätze der Prävention (bisher: BGV A1) Ausgabe 2009-01

[5] Gesetz über die Durchführung von Maßnahmen des Arbeitsschutzes zur Verbesserung der Sicherheit und des Gesundheitsschutzes der Beschäftigten bei der Arbeit (Arbeitsschutzgesetz - ArbSchG) vom 7. August 1996 (BGBl. I S. 1246), zuletzt durch Art. 427 der Verordnung vom 31. August 2015 (BGBl. I S. 1474) geändert

[6] Verordnung über Sicherheit und Gesundheitsschutz bei der Verwendung von Arbeitsmitteln (Betriebssicherheitsverordnung – BetrSichV) vom 3. Februar 2015 (BGBl. I S. 49), zuletzt durch Artikel 15 der Verordnung vom 2. Juni 2016 (BGBl. I S. 1257) geändert

[7] DGUV Information 211-006 Sicherheit und Gesundheitsschutz durch. Koordinieren (bisher: BGI 528). Berufsgenossenschaft Holz und Metall, Ausgabe 2013-11

[8] DIN EN 60204-1: Sicherheit von Maschinen – Elektrische Ausrüstung von Maschinen, Teil 1: Allgemeine Anforderungen, Ausgabe Juni 2007, Beuth Verlag GmbH, Berlin

[9] DIN EN ISO 12100 Sicherheit von Maschinen, – Allgemeine Gestaltungsleitsätze – Risikobeurteilung und Risikominderung; 2011-03, Beuth Verlag GmbH, Berlin

[10] DGUV Regel 113-004 Behälter, Silos und enge Räume, Teil 1 Arbeiten in Behältern, Silos und engen Räumen (bisher: BGR/GUV-R 117-1); Deutsche Gesetzliche Unfallversicherung, Ausgabe September 2008, aktualisierte Fassung Juli 2013.

[11] Internet: www.dguv.de/fb-holzundmetall Publikationen oder www.bghm.de Webcode: <626>

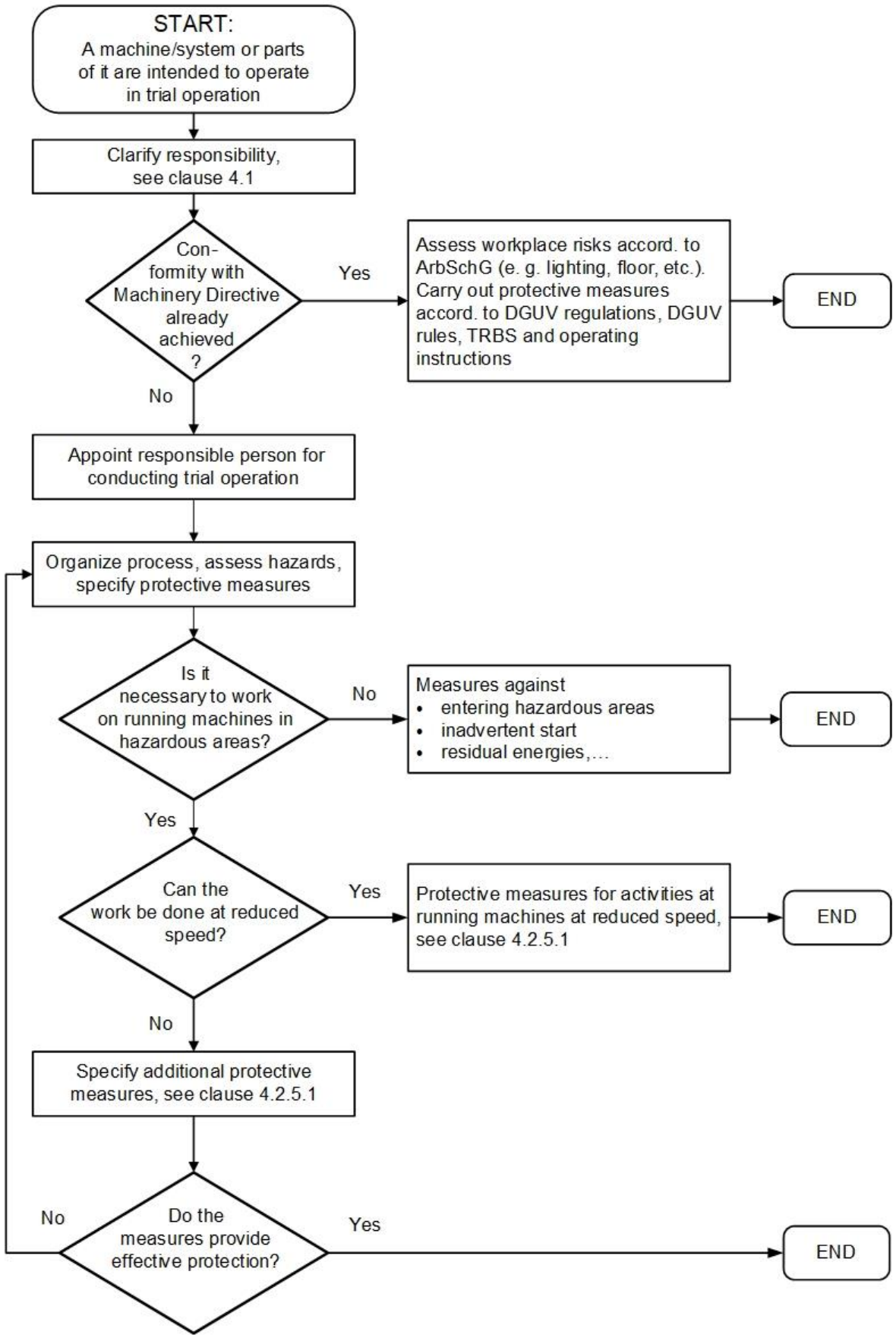
[12] DGUV Information 211-005 Unterweisung – Bestandteil des betrieblichen Arbeitsschutzes (bisher: BGI 527); Berufsgenossenschaft Holz und Metall, Ausgabe Juli 2012

Picture credits:

The pictures mentioned in this “Fachbereich Aktuell” have been kindly provided by

Figures 1, 2, 3, 4: FB HM, SG MRF

Annex 1: Flow diagram for the determination of protective measures for trial operation



Annex 2: Contents of instructions

Instructing employees involved in trial operation

Instructions have to be given on site and with regard to the relevant assembly of machinery prior to the first trial operation. If necessary, general instructions (to all employees working on the assembly of machinery) and special (task-related) instructions can be provided. Information on instructions is also contained in DGUV Information 211-005 (previously: BGI 527) [12].

Instruction topics:

- **Behavior in case of danger, accidents and malfunctions**
  (Escape routes, first aid, alert of fire department, emergency doctor, supervisor)
- **Organization of trial operation**
  - responsibility
    (principal responsible person, area manager, availability, substitution)
  - switching authorization
    (who is allowed to start individual machines and assemblies of machinery?)
  - sequence of trial operation
    (when and how should the individual parts of the assembly be tested ? Which preparatory activities must be carried out and in which order?)
- **Hazards during the individual operating states**
  General hazards, special hazards - related to certain machines (parts) - and hazards which are difficult to identify. Where are danger areas, where are protection areas and how are they marked?
  (e.g. dangerous movements, overrun, falling, electric current, falls / crashes, fire hazard, hot surfaces, laser, flying sparks, gases / vapors / smokes, ...)
- **Technical protective measures**
  Which systems are already working, which are not? Which devices have to be bypassed for which reasons? (e.g. emergency switch off circuits, fences / warning tapes, circuit breakers, light barriers, scanners, enabling switches, reduced speeds, ...)
- **Organizational protective measures**

  Who works what and in which place? (Temporal and local regulations)

  When must work on live parts/systems be done and by whom? (only for troubleshooting, only by a qualified electrician)

  Working in the danger area only after having been instructed!

  Activities in the danger area only with protective measures
  - if the assembly is at a standstill: against putting into operation (padlock, disconnect plug, ...)
  - while the assembly is running: for timely stop (enabling switch, ...)

  Are warning signals used? (e.g. horn, flashing light)
- **Personal protective measures**

  Which PPE is required at what time? (e.g. safety shoes, safety goggles, ear protection, helmet, gloves, insulated tools, ...)
- **Use of work equipment**

  Use, care, inspection, maintenance, transport of tools, special tools, equipment, machinery, accessories. Proper use and dangers of misuse.
- **Dealing with hazardous substances**

  How can hazardous substances be identified? Which substances may be used? How should the substances be used? Which protective measures must be observed?

Publisher

Deutsche Gesetzliche
Unfallversicherung e.V. (DGUV)

Glinkastraße 40
10117 Berlin
Telefon: 030 13001-0 (Zentrale)
Fax: 030 13001-6132
E-Mail: info@dguv.de
Internet: www.dguv.de

Sachgebiet „Maschinen, Robotik und Fertigungsautomation“
im Fachbereich „Holz und Metall“
der DGUV > www.dguv.de Webcode: d544779