ACCIDENTS CAUSED BY ELEVATOR SYSTEMS

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Abstract: In 2021, 15 incidents involving personal injury occurred on elevator equipment. The majority are less serious incidents. These are related to users tripping and falling. Significantly, there have been serious and fatal accidents involving installation and maintenance personnel in the recent past. The article provides an insight into the legal basis and its requirements for lift systems requiring monitoring. In addition, an insight is given into the accident statistics of personal injuries to lifts and the findings derived from them.

Keywords: lift systems, accidents, legal requirements.

Introduction

Accidents and claims are a sensitive and difficult issue for publications in many respects. This is also the case in the field of elevators. What can be used for this paper is publicly accessible and anonymized information, not internal and confidential findings from expert activities or committees. Accident investigations involve confidentiality with regard to third parties, so this is another reason why this paper contains only general explanations of accidents and no specific reference to particular events and their causes. Accident occurrences in Germany are presented, the boundary conditions are explained and findings from them are shown.

The legal basis and requirements

When it comes to the subject of accidents and accident statistics, the keyword “dark figure” is mentioned time and again, and it can be assumed from this that the statistics published in isolated cases to date, as well as the few media reports, only provide an incomplete picture of the accident situation in elevator technology.

There are no current, comprehensive and therefore reliable statistics on accidents in the materials handling industry in Germany. Although various institutions, including the TÜV association and the employers’ liability insurance associations, collect data on accidents in various areas of materials handling technology, these are incomplete. This incomplete evaluation arises because the intended reporting processes are not implemented in practice or are inadequate because interfaces between the various persons and institutions involved do not exist or are not operated.

At the same time, the legal requirements for the operator or employer are clearly regulated and his obligations in the event of an accident or damage are adequately described.

The following regulations, among others, define the requirements for handling accident and damage cases:

- Industrial Safety Ordinance (BetrSichV), applies to all work equipment
- Law on installations requiring monitoring (ÜAnlG)
- Technical rules for operational safety (TRBS, …)

§ 1 Scope of application Law on installations requiring monitoring in Law on installations requiring monitoring:

This law applies to the construction, modification and operation of plants requiring monitoring. It serves to ensure the safety and health protection of employees and other persons who are in the danger zone of such a plant during operation [1: 2].

§ 1 Scope and objectives of the Ordinance on Industrial Safety and Health:

With regard to the (...) systems requiring monitoring, this ordinance also regulates measures for the protection of other persons in the danger zone, insofar as these can be endangered due to the use of these systems by employers (...) [2: 2].

The employer's obligations in the event of accidents and damage are described in § 19 of the BetrSichV dated 03.02.2015, which states that:

In the case of work equipment in accordance with Annexes 2 and 3, the employer must notify the competent authority without delay of the following events:

1. any accident in which a person has been killed or seriously injured, and
2. every case of damage in which components or safety equipment have failed.

Note: Annexes 2 and 3 of the BetrSichV list systems requiring monitoring, such as elevator systems and "certain work equipment", including crane systems [2: 15].

In paragraph 2 of § 19 BetrSichV, further requirements regarding accident and damage events are addressed to the employer:

(2) In the case of installations requiring inspection, the competent authority may require the employer to have the event to be notified in accordance with Paragraph 1 assessed in terms of safety at his own expense by an approved inspection body, if possible, determined by mutual

agreement, and to submit the assessment to the authority in writing. The safety assessment shall cover in particular the following findings,

1. what the event was due to,
2. whether the plant requiring inspection was in an unsafe condition and whether a hazard no longer exists after the defect has been rectified, and
3. whether new findings have been made that require different or additional safeguards [2: 16].

In addition to media reports, the safety assessments of the approved inspection bodies are included in the statistics of the TÜV Association and are discussed in the exchange of experience of the approved inspection bodies. This implements the requirements of § 13 ÜAnlG dated 27.07.2021, in which the approved inspection bodies are required to exchange the knowledge they gain from their activities with other approved inspection bodies.

This exchange of experience also extends to recurrently inspected elevator systems. In 2020, for example, around 637,000 installations were inspected in Germany with regard to their operational safety. Of these, 43 percent had minor defects, 11 percent had safety-relevant defects and 0.7 percent had been identified as dangerous defects [3: 5).

Further requirements and obligations for handling § 11 of the BetrSichV dated 03.02.2015. Here it says:

"(…) The employer must ensure that employees and other persons can be rescued and given medical attention without delay in the event of an accident or emergency. This includes the provision of suitable access to and into the work equipment as well as the provision of necessary fastening options for rescue equipment on and in the work equipment (…)".

The employer must ensure that the necessary information on measures to be taken in the event of an emergency is available. The information must also be available to rescue services, insofar as it is required for rescue operations [2: 10].

The requirements are generally largely implemented by the technical design and the emergency plan for elevators in buildings. It is more difficult with elevators in very exposed operating locations or workplaces, such as elevators for crane operators or elevators in wind turbines. In the course of the expansion of regenerative energy sources and the energy turnaround, the number of elevators in wind turbines is increasing and the lifting heights are becoming greater and greater. Hub heights of 160 meters and more in wind energy plants require a hoisting height that is very significantly higher than that of the majority of elevators in buildings. Accidents have also brought wind turbines and the elevator into focus as a central means of

transport and work. These elevators have not only technical but also operational characteristics. These installations have been little in the focus of the committees.

Specified in the TRBS 3121 „Technical rules for operational safety – Operation of elevator systems“ as follows:

„The employer who provides an elevator system must ensure that the rescue of trapped persons can be carried out at any time and in the shortest time possible,“

and:

„In the case of installations whose accessibility or access is not obvious due to special features of the operating site (e.g., elevator installations in wind turbines, within large buildings or extensive operating sites), locatability shall be ensured by additional information, for example by geographic coordinates or visible markings on the buildings and structures“ [4: 6].

A media report last year on a difficult and lengthy rescue, where a fitter suffered a serious injury due to a lightning strike in the nacelle of a wind turbine[1], impressively illustrated the difficulties and challenges. Further specifications, in particular for elevators in wind turbines and facade access systems (facade elevators), are to be included in TRBS 3121 in the future.

Taking these regulations and requirements into account, it should therefore be possible to obtain a complete picture of the accident situation, at least for elevators in Germany. However, not every elevator is work equipment and not every accident occurs in a commercial environment or involves employees. As a result, there is a gap that makes comprehensive statistics impossible.

In 2021, 15 incidents involving personal injury in elevator systems came to the attention of the TÜV Association via a safety assessment in accordance with Section 19 of the BetrSichV and media reports. Of these, two accidents were fatal. In 2020, 18 accidents and incidents with personal injury were known to the TÜV Association and one fatal accident was recorded [5: 4p].

The majority of incidents, most of which are also less serious, are associated with users tripping and falling, for example as a result of inadequate holding accuracy of the elevator car, and injuries caused by car door movements. Significantly, several recent serious fatal accidents involving installation and maintenance personnel have been directly related to machine room-less elevators and, in some cases, temporary shelters. The advantages for a machine room-less (machine room-less) elevator system is a space-saving installation, since additional living space can be created by eliminating a machine room [6: 34].

However, this space-saving installation means that missing protective spaces have to be provided by additional safeguards. In these cases, misuse or disregard of work instructions is the cause. In recent years, these temporary shelters have created new and additional hazards at elevator installations, which are now also reflected in the accident statistics. The effectiveness and, in particular, the practicability of technical and, at the same time, necessary organizational protective measures are increasingly coming into focus here.

There are also some general conditions to be observed here with regard to the scope of the recording of accident occurrences. The German Social Accident Insurance (DGUV) points out in its statistics that „the explanations and analyses of accident occurrence (...) always refer to occupational accidents during an operational activity (...) as well as to the collective of insured persons of dependent employees and entrepreneurs, cooperating relatives as well as insured persons of BG Bau during non-commercial construction work". Furthermore, "that data on reportable accidents are extrapolated figures based on a sample" [7: 15].

This representative sample consists of approximately 6.7 percent of the reportable accidents for the industrial accident insurance institutions and 10 percent for the public accident insurance institutions. In the case of fatal accidents, full coverage of 100 percent is available [7: 7].

Table 1. Accidents with conveying equipment in 2020

	Notifiable accidents	Fatal accidents
Escalators	165	0
Elevators (cargo, passenger)	645	1
Cranes	1.038	3

The statistics of the German Social Accident Insurance (DGUV) are also not all-encompassing, since only "commercial incidents" in connection with employees and other insured persons of accident carriers, such as volunteers (volunteer firefighters, helpers in accidents) are recorded here.

If we look at the user group of elevator systems, the focus is on less serious accidents. These are often crushing and falling accidents. The injured parties are mostly people who are already physically limited, such as senior citizens and patients in hospitals. Here, the importance of considering a user group and a user environment in relation to the state of the art for safe elevator systems becomes apparent.

From the accident records, it can be seen that in the past several fatal occupational accidents during maintenance and installation work had characterized the accident occurrence in elevator systems. Fatal accidents involving users were few to none.

The causes of accidents may include:

- Manipulations
  - of time or performance pressure such as piecework or
  - to determine the availability of a work equipment or plant [8: 3],
- Chain of "unfortunate circumstances",
  - adverse environmental conditions,
  - insufficient knowledge of the facilities and/ or the environment,
  - misunderstandings due to insufficient communication and agreements [9: 11].
- inadequate working equipment for use,
- improper use and operation outside the parameters,
  - overloading [4: 5].
- Failure to follow technical and / or organizational protective measures,
  - Elevator with temporary protection room [10: 14].
- Variety of protection concepts is the insufficient operating instructions [11: 20],
- Working without employees (working alone) and
- routine.

In addition to the personal fate of the person affected, there are often far-reaching consequences for the employer or operator and other parties involved. The operating site, the construction site, production and the workplace are largely shut down until evidence is secured and the on-site accident investigations are completed. As a rule, the following persons are involved in this process [12: 12]:

- Public Prosecutor's Office,
- criminal investigation department,
- Operator or persons with operator duties,
- maintenance company,
- Surveyor/ expert.

If it is a work equipment, additionally the:

- Employer's Liability Insurance Association,
- Occupational safety authority or "competent authority" according to ÜAnlG,
- Employer or disciplinary superior to whom employer duties have been assigned,
- persons responsible for occupational health and safety in the company concerned,

- media representatives,
- …

The following documents may be required in the context of accident investigation:

- Risk assessment for the work equipment and/or
- Risk assessment for the activity,
- work and operating instructions,
- Qualification and proof of suitability of affected and responsible persons,
- Proof of instruction in occupational health and safety,
- proof of working hours,
- technical documentation such as operating instructions and proof of the required tests,
- documentation of the specifications between the trades.

Is the occurrence of accidents in every case inextricably linked to the risk of a piece of work equipment or plant and are accident statistics alone suitable for deriving measures?

The term risk, which is often used in regulations as well as in the Act on Installations Requiring Inspection (ÜAnlG), can be understood very differently, especially with knowledge of functional safety and its probabilistic (also: probability statement). In the definitions of the ÜAnlG it says: „For the purposes of this Act, installations requiring inspection are installations (...) which, when operated, pose significant risks to the safety and health, in particular, of employees. (…)“ [1: 2].

In the ÜAnlG, this does not mean a mathematical consideration, i.e., the product of probability of occurrence and extent of damage, but rather a colloquial combination. In the design of safety functions for process plants and machinery, the probabilistic approach, i.e., the calculation of the probability of failure of a component or the probability of occurrence of an event, is certainly possible and proven. For activities in occupational safety and health, where the focus is on prevention, this approach is difficult.

In occupational safety, it is not a matter of limiting the probability of a certain damage, but of avoiding the event in the first place. What works in the technical field, for example in the design of protective functions of machines according to Safety Integrity Level or Performance Level with probabilistic methods, is often not possible in occupational safety. In the relevant literature, the term hazard denotes „the possibility of damage or impairment to health without specific requirements as to its extent or probability of occurrence “ [13: 1].

With regard to occupational health and safety and its operational aspects, the term "the hazard" is clearer and more suitable. Target-oriented statements can be made, and measures derived from the various hazard factors of work equipment, taking into account corresponding limit values. A hazard-based approach is preferable to a risk-based or probabilistic approach, considering the objectives of occupational health and safety and the operational aspects of work equipment.

Furthermore, the incomplete data on the occurrence of accidents does not allow a reliable value to be determined for the probability of occurrence in the area of elevator systems. Due to positive general conditions that currently ensure the safe use of elevator systems, such as the interaction of maintenance and testing, there is also the possibility of false causalities in conjunction with the low accident figures. These causalities can lead to the eventual prevention paradox.

Also, correlation of variables does not necessarily mean causality. A high correlation may indicate causality, but there may be other explanations. It can be based on coincidences, where the variables appear to be dependent but have no true relationship to each other. Thus, in conclusion, the question can be answered in the negative as to whether the number of accidents alone is in every case a suitable measure for deriving the risks of a piece of work equipment or elevator system or even measures from them.

Conclusion

What seems to be adequately regulated in terms of accidents and damage, still shows potential for improvement. The question remains as to where corrections need to be made or where obligations need to be more consistently enforced in order to obtain reliable data on the occurrence of accidents in systems requiring monitoring, such as elevator systems.

The elevator brings with it a high degree of technical safety, not least due to the know-how that has been expressed in a large number of product standards over decades. As a system requiring monitoring, an elevator is subject to stringent requirements in terms of testing and monitoring. This continuing high quality standard and the competence of the manufacturers, installation companies and monitoring bodies (TÜV, DEKRA, ...) do the rest to ensure that elevators are regarded as a comparatively safe means of work and transport.

Notes

[1] **Bruning, Reinhart**. Mechanic suffers serious injuries from lightning strike in nacelle of wind turbine. // WDR Quarks. 2 September 2021, https://www.ardmediathek.de/video/Y3JpZDovL3dkci5kZS9CZWl0cmFnLWJmMDA5ODQ3LTA5MGQtNGE0ZC1iN2YxLTc5MTM5M2EwOWI0Mg/ (27 March 2022).

References

1. **Federal Ministry of Justice and Consumer Protection.** Law: On installations requiring monitoring (ÜAnlG), 2021, Pages 2 – 5.
2. **Justice and for Consumer Protection.** Ordinance on Safety and Health Protection in the Provision of Work Equipment and its Use at Work: Safety in the Operation of Installations Requiring Inspection and on the Organization of Industrial Safety and Health, 2002, Pages 2 – 17.
3. **TÜV Association.** Plant Safety Report: Technical monitoring, Volume 62, 2021, Pages 5 – 6.
4. **Operational Safety Committee.** TRBS 3121: Technical rules for operational safety – Operation of elevator systems, 2018, Page 6.
5. **Stohlmann,** Axel. Accident history in materials handling: Cable cars, elevators, escalators, 2022, Pages 5 – 6.
6. **Unger,** Dieter (2018): Elevators and Escalators: An application guide, Volume 3, 2018, Pages 34 – 35.
7. **German Social Accident Insurance**. Statistics: Occupational accident statistics, 2020, Pages 5 – 15.
8. **Otto,** Stefan. Safety & Health: Checklist Manipulation of protective devices, 2018, Page 3.
9. **Professional association wood and metal.** DGUV information 209-053: Activities on elevator systems, 2017, Page 11 – 12.
10. **Professional association wood and metal.** DGUV information 209-085: Hazard warning lights for maintenance work on elevators, escalators and moving walks, 2017, Page 14.
11. **Professional association wood and metal.** DGUV information 211-010: Safety through operating instructions, 2019, Page 20.
12. **Paradissis,** Alexander. Investigation proceedings after accidents at work: Requirements for the criminal law representation of the company, Cologne: Journal of the Economic Criminal Law Association, 2020, Pages 1 – 12.
13. **Sladeczek,** Frank. Hazard-free regular operation of production plants: How much hazardous substance-related individualized precautions make sense, 2016, Pages 1 – 2.

About the author

Mark Dietz works as an expert in the field of materials handling technology and is responsible, on the one hand, for acceptance tests and periodic inspections of elevator systems and their special installations. As an expert, the author also certifies quality management systems and follows forward-looking developments in elevator technology. These activities extend to tasks in the Centre of Competence (CoC) in the area of functional safety, in particular in various working groups, which include, for example, the testing and inspection of safety-related control systems and their safety software.

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