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# Safety of tractors – history and prospect

Due to operating conditions the aspects of safety at work and health protection play a substantially larger role in the development and operation of tractors contrary to other motor vehicles. At the beginning of the European harmonisation of the type approval of tractors more than 40 years ago it was therefore already determined that for these vehicles apart from the road safety also the safety at work must be considered by appropriate requirements and test methods. In this article, the history of the development of the safety regulations is highlighted and tried to give a prospect on the further development.

## Keywords

Tractors, harmonisation, technical regulations, safety at work, health protection, accidents

## Abstract

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■ In the mid-1960s, work commenced on harmonising the requirements imposed on motor vehicles within the then EEC. At the same time, tractors were placed under a separate regulatory framework. At the insistence of the German Agricultural Health and Safety Insurance Association (Bundesverband der landwirtschaftlichen Berufsgenossenschaften), consultations on operator safety were instituted in parallel to negotiations on road safety requirements. Over the years, a regulatory framework has grown up consisting of a framework directive, which regulates the administrative process for type approval, and 24 separate directives containing detailed technical specifications. Eleven of these separate directives consist exclusively or primarily of requirements arising from operator health and safety considerations [1].

## Milestones in tractor safety – roll-over protective structures

A key feature of accidents involving tractors is rolling or tipping over of the vehicle. Until around 1970, accidents of this type resulted in more than 200 deaths per year. Since it is not possible to prevent tractors from rolling or tipping over through design-related measures, there was a need to find a solution which would protect drivers from serious or fatal injury in the event of roll-over. From 1969 onwards, extensive testing and calculations were carried out at the Technical University of Munich, with the aim of developing appropriate protection structures [2]. The results of this costly and time-consuming

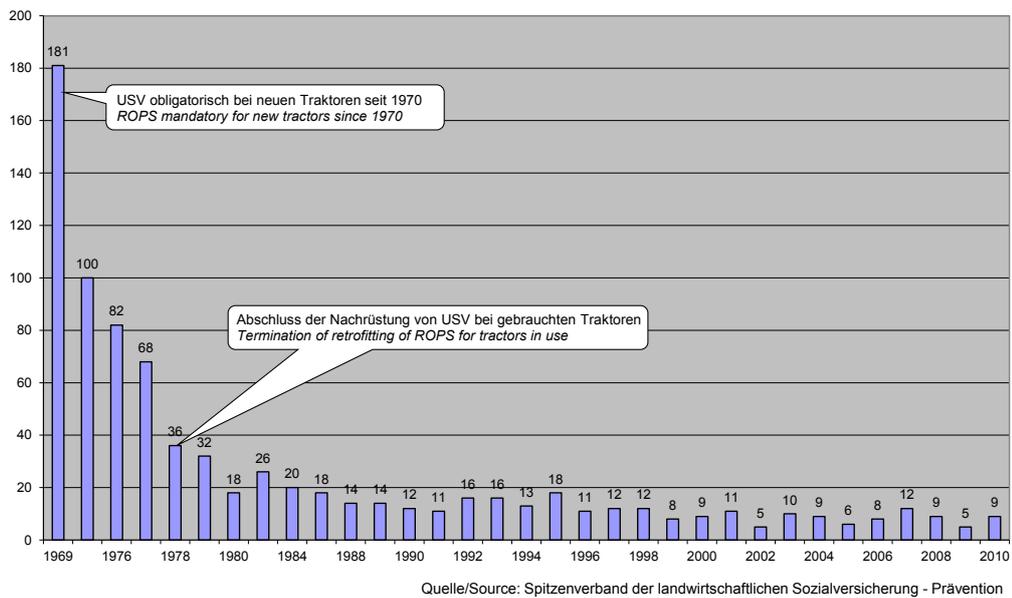
work, which received financial support from the tractor industry, the German Agricultural Machinery and Farm Tractor Association (former LAV – Landmaschinen- und Ackerschlepper-Vereinigung) and the German Agricultural Health and Safety Insurance Association, led to clearly defined requirements and testing procedures and were thus able to contribute to major improvements in the strength of protection structures.

A further important result of this work was the production of a calculation method enabling protective structures to be designed so that a tractor on a defined incline will, in the event of roll-over, not continue to roll. From 1970, German legislators introduced measures requiring new tractors to be equipped with roll-over protective structures. From 1975 to 1977, tractors already in use were also required to be retrofitted with roll-over protective structures. Between 1969 and 2010, the introduction of roll-over protective structures on tractors reduced the number of people killed annually as a result of tractors rolling over by more than 90 percent (**Figure 1**). For this achievement, German President Karl Carstens in 1981 awarded Prof. Dr.-Ing. Walter Söhne, a Professor at the Technical University of Munich's Agricultural Machinery Institute, the Order of Merit of the Federal Republic of Germany [3]. Today, there are a total of four directives on roll-over protective structures for tractors, covering dynamic testing, static testing and two dealing with narrow tractors. In Europe, however, dynamic testing (the pendulum test) has in practice now been rendered more or less irrelevant.

## The truth about the tractor seat directive

The tractor seat directive 78/764/EEC [1] is unjustly cited as an example of overregulation. Its necessity arises from the demands of occupational safety. Tractor seats need to possess vibration and shock-absorbing properties in order to prevent tractor drivers from incurring serious or chronic intervertebral

Fig. 1



Fatal accidents by overturning and tipping of tractors

disk damage. Exposure times are, at least on difficult and uneven terrains, up to 1,500 h per year. The directive defines both requirements and test procedures. In addition to a laboratory test using a vibration test stand, the directive also specifies a road test track. Because the laboratory test procedure is not applicable to tractors with full suspension systems, the two test procedures continue to coexist. The road test track is 100 m long and consists of two strips into which are set, at 16 cm intervals, wooden blocks of differing, but precisely defined heights. The limit defined in the late 1970s of a maximum of 1.25 m/s<sup>2</sup> for the vertical acceleration of the seat still holds today. Directive 2002/44/EC on limiting workers' exposure to vibration in the workplace [4] specifies a limit of 1.15 m/s<sup>2</sup>, though within a different framework. Experts agree, however, that, in view of the differences in the testing and evaluation procedures, the two values correlate.

### Tractor safety – state-of-the-art

The European safety framework for tractors was rounded off by a number of further directives. These cover the passenger seat, limits for the level of noise at the driver's ear, protective devices for power take-offs and speed governors and protection of drive components and hot surfaces in proximity to any steps.

Ergonomic requirements relating to access to the driver's cab and to operating space for controls and requirements for the fitting, position, mode of operation and labelling of tractor controls have also been defined.

The directives are adapted to technical progress as required. This is achieved via a simplified procedure known as the 'comitology procedure'. If the responsible committee, made up of representatives of the Member States, passes a motion by

a qualified majority vote, the European Parliament has three months to lodge an objection, after which, if it declines to do so, the European Commission will issue a proposal for a directive.

Ongoing safety improvements have also been achieved in one area not covered by the regulations – reliability. The absence of interruptions to work processes helps to prevent accidents. Comfort-related and ergonomic factors, such as cab air conditioning and ease of use, can also help reduce accidents by making tractor operation less tiring.

### Tractor safety – no differences to the Machinery Directive any more

The new version of machinery directive 2006/42/EC saw an end to the complete exemption of tractors from this legislation. Since 29.12.2009, they have been exempted only in respect of "risks covered by Directive 2003/37/EC" [5]. For the industry, for governmental authorities and for other organisations, this has given rise to the unsatisfactory situation of having to apply two sets of regulations which are incompatible in terms of how conformity is assessed and in terms of the regulatory approach. The remaining issues described in [5] which were not yet covered by tractor directives have since been incorporated into the regulatory framework for tractors through directive 2010/52/EU [1]. This entered into force on 02.09.2010 and has been applicable to new tractor types since 02.09.2011. It will apply to all new tractors entering the market from 02.09.2012. According to one of this directive's recitals, all risks described in the machinery directive for tractors will, with the entry into force of this directive, be covered by regulations in separate directives. As long as the manufacturer meets the requirements imposed by these and all other directives applicable within the

framework of the EU's type approval procedure, the machinery directive will no longer be applicable. It will also no longer be necessary to issue a declaration of conformity or to undertake CE marking. Where additional risks arise as a result of technological developments, they will have to be dealt with within individual regulations through the use of the comitology procedure.

## Outlook

Ongoing technical development of tractors will mean that safety regulations will continue to need updating in the future. Before doing so, legislators need to examine whether any proposed measures will achieve the desired effect. Accident statistics do not, for example, currently permit us to determine whether a legal requirement to equip tractors with seatbelts would succeed in further reducing the number of deaths resulting from tractor roll-over events. It is, however, posited that wearing a seatbelt could prevent drivers from being flung out of the defined survival space and becoming trapped under the tractor in the event of a tractor rolling over. Since 01.01.2010, tractor manufacturers have therefore been fitting all tractors which have to be equipped with a roll-over protective structure with seatbelts.

Improving direct and indirect fields of vision from tractors is another area which could bring further safety improvements. This measure is based on operator safety, road safety and ergonomic factors. In Germany, specific ideas for improving vision from tractors have already been agreed between the industry, occupational safety organisations and road traffic authorities and submitted for international standardisation. The corresponding standard is likely to be completed in early 2013.

Accident statistics show that there is a risk of accidents during fault rectification where equipment drives, for example, are not switched off whilst work is being carried out. The industry will work towards equipping future tractor models with operator presence controls (OPC), which automatically switch off all equipment drives when the driver leaves the cab.

Safety in agricultural operational processes cannot, however, be reduced to safety equipment on technical systems. Complex, high-performance systems in particular demand a high level of operator education, training and care. It may be that operators will in future require specific qualifications in order to be permitted to use certain machines.

## Conclusion

From the outset, health and safety has, alongside road safety and environmental protection, been a key component of the harmonisation of European technical regulations for tractors. A high level of safety was achieved very early in the process. Safety has been continuously developed and is still in accordance with the state of the art. In the future, new technologies with appropriate electronic control capabilities will facilitate attaining further safety improvements. Health and safety in the agricultural sector also imposes requirements on the behaviour and qualifications of farmers and contractors.

## Literature

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