

SAFETY REQUIREMENTS FOR ADJUSTABLE FURNITURE WITH ELECTRIC ACTUATORS

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Abstract

This article presents a reflection on the need for a new formulation of safety requirements for positioning furniture with electric actuators. The current applications of adjustable furniture in the area of office furniture, home furniture, bed and kitchen furniture with electric actuators indicate the backwardness of existing safety standards, which do not correspond to the actual situation or development trends in adjustable furniture. If adjustable furniture with electric actuators contains security features, a contact safety system is used. Any development of new contactless security systems enables to further exploit the potential of adjustable furniture with electric actuators.

Key words: *adjustable furniture; electric actuators; safety requirements; safety distance; safety factor.*

INTRODUCTION

In many furniture areas, electric actuators are being used for a long time in adjustable furniture - hospital beds, adjustable bed bases of residential beds, adjustable office desks. Adjustable furniture with electric actuators is gradually applied in other areas of furniture - adjustable kitchen furniture, adjustable seating furniture and more. Some applications of adjustable furniture with electric actuators are fitted with safety devices. Many applications of adjustable furniture with electric actuators do not contain security features and comply with the prescriptive requirement to comply with the security gap of 25mm between each other moving parts and use controls that require a continuous push on the button to initiate movement.

OBJECTIVE

This article aims to initiate discussion on current security requirements for adjustable furniture with electric actuators. The outcome of this debate should be the assessment of the real development on the current market and the formulation of trends in further development, the characteristics of technical solutions of existing contact safety systems, the definition of the current safety requirements for adjustable furniture. The subsequent output may be activities aimed at addressing professionals in this field, involved manufacturers of adjustable furniture or components and the creation of a working team for the amendment of relevant standards. At the same time, these outputs may initiate development of contactless new generation security principles.

MATERIAL, METHOD, EQUIPMENT

Electric doors

The European standard EN 14749:2005¹ requires that all movable parts accessible at normal operation must have in any position during movement safety distance $\leq 8\text{mm}$ nebo $\geq 25\text{mm}$, except doors, hinged doors and extension elements.

Electric actuators already routinely provide opening and closing of drawer base cabinets, tilting and folding slatted doors of upper cabinets. In most of these cases, the actuator forces are small and there is no injury to the user, when leaving the fingers between moving parts. The requirement to maintain 25mm gap is therefore not necessary for maintaining security.

Rarely however appears specific applications with strong actuators which can cause great risk of injury to the user. Possible application of safety distances between movable parts according EN 14749:2005 will not ensure required safety.

¹ EN 14749:2005 Domestic and kitchen storage units and worktops - Safety requirements



Fig. 1.

Electric opening of drawers Grass Sensomatic, electric opening of top hinged doors Blum Servo-Drive, electric lamella doors Kesseböhmer Climber



Fig. 2.

Electric opening of folding doors Warendorf Hidden Kitchen

Height-adjustable office desks

The European Standard EN 527-2:2002² define general design requirements to minimise the risk of injury to the user:

- movable and adjustable parts are designed to minimise the risk of injuries and inadvertent operation or release
- the safety distance between accessible movable part is either $\leq 8\text{mm}$ or $\geq 25\text{mm}$ in any position during movement. This applies to any elements moving relative to each other, with the exception of doors (including hinges) and extension elements (including runners).

A gap of 25mm must be maintained between the height-adjustable desk from the wall, panel or cabinet furniture, but also between two height-adjustable desks that are placed side by side.

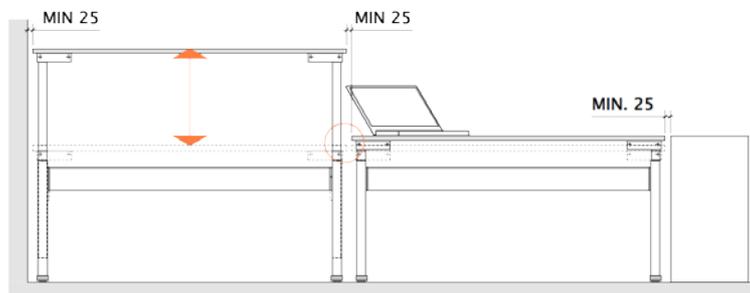


Fig. 3.

Office table safety requirements

This measure does not prevent possible damage to objects under the table top when moving the tabletop down. This measure will not also prevent possible injury if the seated person stretches his or her legs and leans them on the table base or the trestle.

² EN 527-2:2002 Office furniture - Work tables and desks - Part 2: Mechanical safety requirements



Fig. 4.
Office table damage and safety risks

Safety system

The safety system Linak Piezo registers resistance that prevents the table from moving up or down. If table hits an obstacle when in motion, the system stops the motion and the resultant pressure is released by moving in the opposite direction.



Fig. 5.
Linak Piezo Anti-Collision Technology

The safety system Linak Piezo can be very sensitive and also records a small impulse during the movement of the tabletop and can prevent damage, for example, of a tablet or mobile phone under the table top. The Piezo system, however, cannot reliably protect the safety of persons, respectively, limbs in risk areas.

Residential beds

Electric actuators are used in the long term for positioning frames of residential beds. These beds are not equipped with safety features to prevent possible injuries of limbs of persons lying on the bed next to it when inserting them in a critical area under the raised head part of the frame.



Fig. 6.
Illustrative photos presenting a risk area under the raised head part of the positioning frame ³

³ Beds of the company LB Bohemia, fair Nábytok & Bývanie 2013, Nitra, SK

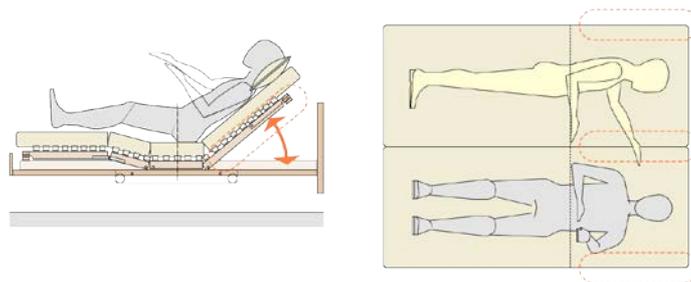


Fig. 7.

Diagram of the positioning bed frame's risk area

The adjustable bed Amore⁴ allows a lift of individual beds of 18cm. The bed is designed to avoid any compression zone or shearing edges and so does not require the application of a security system.

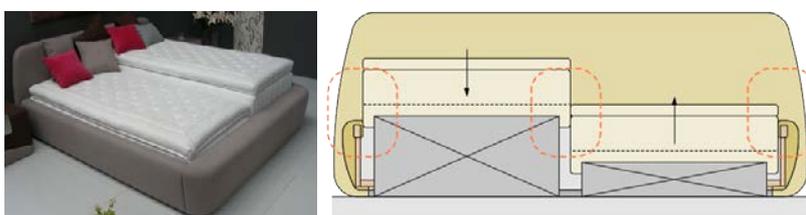


Fig. 8.

Amore Bed without risk areas of injury

Currently, there are new types of residential beds, which allow adjusting the height as well as the bed tilt⁵. The electric actuators of these adjustable beds must be sufficiently large, the force exerted when lifting the bed is the same as the force when moving beds down. This creates a risk zone between the bed frame and the floor.

The European standard EN 1725:1998⁶ requires safety distance between moving part from the floor $\geq 100\text{mm}$ to prevent feet being trapped.



Fig. 9.

Cubana Bed, Bed Suite-emotion, Diagram of the adjustable bed risk area

Contact safety elements

The applications of electric actuators in furniture can be problematic requiring significantly stronger drives that already could cause personal injury or property damage. Applications that do not contain dangerous places can be safely used without security systems. Conversely, applications of adjustable furniture containing dangerous places (pressure points and cutting edges) should be equipped with a safety system that prevents injury to persons, animals or property damage. Current contact safety systems are using, for example, security cables. The cable has two conductors that touch while pressing the cable and this contact is evaluated by a control unit that stops the actuators, or returns them back a bit.

⁴ Amore Bed, producer Nadop, fair Mobitex 2011, Brno, CZ

⁵ Cubana Bed, producer Otten Matrazen, fair imm 2013, Suite Emotion Bed, producer Stieglmeyer, fair imm 2015, Köln, DE

⁶ EN 1725:1998 Domestic furniture - Beds and mattresses - Safety requirements and test methods

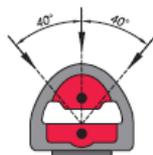


Fig. 10.
Mayser Safety Cable scheme

Height-adjustable kitchen

A pioneer in height-adjustable kitchen furniture is the kitchen K7⁷ of the company Team7. The kitchen is equipped with a contact safety system that ensures that the movement is stopped when there is contact of an object with the bottom surface of the counter.



Fig. 11.
The usability principles of the height-adjustable kitchen counter of the kitchen K7



Fig. 12.
A view of the K7 kitchen's bottom surface with the contact safety system

The company Häfele gradually presents in Interzum exhibitions since 2007 the vision of adjustable furniture, including the height-adjustability of kitchens. The initial presentations were marked by the appearance of high-risk cutting edges that were protected by unattractive optical sensors. The optical sensors were gradually replaced by safety cables.

The concept of the Häfele Functionality height-adjustable kitchen blocks⁸ shows no risk cutting edges, the height adjustable cooktop block moves right along the fixed part, the lifting height is limited to not form a cutting edge. The minimum gap does not create a risk area for personal injury or property damage. Security measures would possibly be appropriate on the lower surface of the sliding blocks.

⁷ Kitchen K7, producer Team 7, 2007

⁸ Häfele Functionality, fair Interzum 2009, Köln, DE



Fig. 13.
Häfele Functionality height-adjustable kitchen

A similar sliding block principle is used by the company Alno in the concept Kitchen Moving, presented at the fair LivingKitchen 2013.

Height-adjustable kitchen Magnific⁹ is equipped with a security system mounted on the bottom surface of the sliding block and the bottom surface of the bar superstructure.



Fig. 14.
Kitchen Magnific with security system

At furniture fairs, manufacturers of kitchens repeatedly present kitchens with attractive both side sliding blocks. This principle, however, brings very risky cutting edges between the shelves and the top plate of the sliding block and the fixed worktop. Without a reliable security system protecting these areas of risk, this principle is very dangerous and unusable. The force required to pull a loaded middle block is sufficient for amputation of fingers left in high-risk areas.



Fig. 15.
Kitchen Horizon¹⁰ with sliding blocks

⁹ Magnific Kitchen, producer Nadop, fair Mobitex 2010, Brno, CZ

¹⁰ Kitchen Horizon, producer Zeyko, fair LivingKitchen 2015, Köln, DE

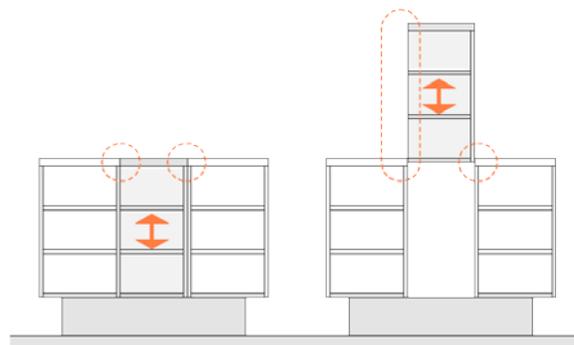


Fig. 16.
Scheme of a sliding block

RESULTS AND DISCUSSION

The examples of above presented adjustable furniture show that the requirement of maintaining safety gap between mutually moving parts either $\leq 8\text{mm}$ or $\geq 25\text{mm}$ (stated in EN 14749:2005, EN 527-2:2002, EN 14073-2:2005, EN 1729-2:2012) does not ensure the safety of the adjustable furniture. In some situations, it is even counterproductive.

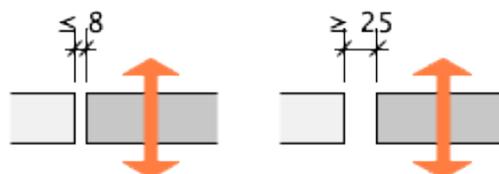


Fig. 17.
Scheme of a safety gap between the moving parts

In the case of adjustable beds as shown in Fig. 8 and 9, the possible gap 25mm between the bed frame and the floor is insufficient and in compliance with this requirement, the risk of injury to the feet of the person standing next to the bed, the injury of an animal lying beside the bed, or damage to objects in the vicinity of the adjustable bed remains. It should be emphasized that for this application it is necessary to dimension the motor force for lifting a lying person including the weight of the bed itself, this power can, when moving the bed frame down, cause serious injury.

In the case of an adjustable working kitchen plate as shown in Fig. 10, the gap in the lowest position between the plate and lower cabinets block is approximately 100mm, which is significantly more than the required 25mm. Essential for safe use is the usage of a contact safety system which detects the contact with the bottom surface of the sliding plate. Loose boards are underslung under the plate, at their heave at contact; the security cable is pressed between the boards and the plate.

In the case of an adjustable kitchen block according to Fig. 12, the minimum vertical gap between the fixed and movable block provides user safety, on the contrary, compliance with the 25mm gap would make this application dangerous. The question that remains is the need to protect the bottom surface of the adjustable block.

In the case of the kitchen sliding shelf as shown in Fig. 14, the minimum 25mm gap between the moving parts would not be visually acceptable. At the same time, gaps could not provide the required security on both sides of the retractable shelf. The safety of this principle is completely dependent on the use of a reliable security system.

CONCLUSIONS

From these examples, it is possible to deduce the need for the formulation of new safety requirements for adjustable furniture that will respect the current trends in furniture applications and also trends in the development of safety systems.

The author proposes, in assessing the safety of adjustable furniture, to divide risk areas as follows: friction zone, compression zone, unidirectional cutting edge and bidirectional cutting edge. The security risk in the friction zones is considerably lower in comparison with the areas of compression zones; the most dangerous are the areas of cutting edges.

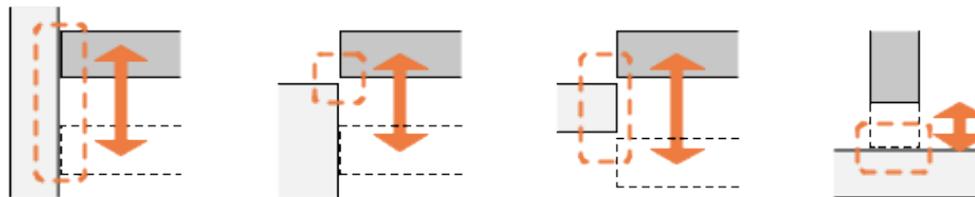


Fig. 18.

Risk zones: friction zone, unidirectional cutting edge, bidirectional cutting edges, compression zone

To assess the safety of adjustable furniture use, the driving force is also important. To assess the safety of adjustable furniture, a formulation of driving force limits for individual risk situations will be needed.

The future development of adjustable furniture will be, according to the opinion of the author of this article, closely linked with the development of new contactless security systems using current and future technologies: For example, miniature cameras with evaluation software, optical, acoustic and other noncontact sensors. There may also be a touch screen technology used in mobile phones. Essential for the development of these new safety systems will be to determine the required parameters: motion detection, incidence of human body parts and animals, inanimate objects detection in high-risk areas.

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SOURCE

- Fig. 1 fair Interzum 2007, Köln, DE; CD Blum Motion; fair Imm 2015, Köln, DE
- Fig. 2 fair Living Kitchen 2013, Köln, DE
- Fig. 5 <http://www.linak.cz/press/shownews.aspx?newsid=2427>,
<http://www.linak.com/about/?id3=2323>
- Fig. 6 fair Nábytok & Bývanie 2013, Nitra, SK
- Fig. 8 fair Mobitex 2011, Brno, CZ
- Fig. 9 fair Imm 2013, Köln, DE; <https://www.suite-emotion.com/en>
- Fig. 10 http://www.mayser-sicherheitstechnik.de/fileadmin/media/Sicherheitstechnik/support/prospekte/EN/Fold-Moebel_enw.pdf
- Fig. 11 <http://www.team7-duesseldorf.de/cs/vareni/k7>
- Fig. 12 fair Nábytok & Bývanie 2011, Nitra, SK
- Fig. 13 fair Interzum 2009, Köln, DE
- Fig. 14 <http://www.truhlarskyportal.cz/clanky/7813-design---trendy---kuchyne-magnific-ziskala-cenu-casopisu-architekt-za-inovace>
- Fig. 15 fair Imm 2015, Köln, DE

Author of illustrative pictures and photos from furniture fairs is Hynek Manak.