EN 81:20/50 as a Key Driver for Technological Innovation in the Next Generation of Lifts

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Abstract. The current EN 81-1 Norm is going to be replaced by EN 81-20 / 50: 2014 on August 31st, 2017. This paper covers some topics to be considered in the implementation of the new standard. In addition, innovative approaches for alternative suspension system and safety devices can also be taken by means of risk analysis, according to the Lift Directive 2014/33 / EU: the introduction of mechatronic systems opens up entirely new ways to dispense with conventional speed limiters in the near future.

To implement such systems, fails-safe electromechanical brakes must also be developed. This is part of a trend in the lift business to reduce the number of required components and integrate them to optimise the use of available shaft space. The challenges to master this technology in the context of a complete lifts, and how to cope with the increasing complexity for installation, testing and maintenance by developing complete 3D models for each project are also discussed in this article.

1 INTRODUCTION

Introduced in August 2014, the new European standards EN 81-20 and EN 81-50 bring considerable benefits in terms of accessibility and safety for both passengers and service engineers.

The familiar EN 81-1 is no longer valid since 31.08.2017 when it was permanently replaced by the new standards. This document covers some of the topics to be considered in the implementation of the new directive in a new lift project.

Where designs diverge from EN 81-20/50:2014, the Lifts Directive 2014/33/EU allow taking innovative approaches by means of risk analysis, specifically concerning the use of innovative safety solutions.

Furthermore, mechatronic systems open up brand new ways to avoid conventional speed limiters in the future, reducing the number of components inside the shaft and allowing bigger cars in the same shaft area. Likewise, we should consider the use of electromechanical safety gear. At the end of the document, we outline the challenges we need to overcome for the successful introduction of the next generation of lifts.

2 SCHEDULE OF LATEST UPDATES OF NORMS AND CODES

- Lifts Directive: 20.04.2016
- EN 81-20/50:2014 31.08.2017
- Draft EN 81-20/50 A1 expected to be released early 2018

3 SIGNIFICANT CHANGES IN EN 81-20 FROM EN 81-1/2

The new EN 81-20 introduces a set of significant changes from the previous standards, which aims to improve safety for passengers and for service engineers as well as clarify and improve the current building interface requirements introducing changes that may affect the building design.

This section gives an overview of the main changes to the safety requirements introduced in EN 81-20 that have to be carefully considered and may have a direct impact on the introduction of PESSRAL (Programmable Electronic Systems in Safety Related Applications for Lifts) system.

3.1 Lift Car Safety Zones

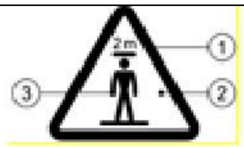
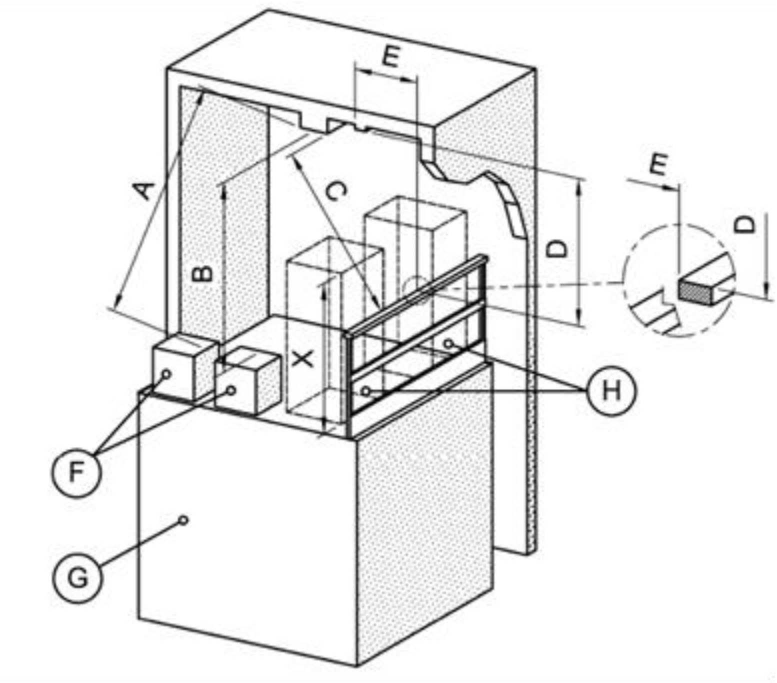
Model	Position	Warning sign	Horizontal dimensions of the safety zone m x m	Height of safety zone m
1	Upright		0.40 x 0.50	2.00
2	Crouching		0.50 x 0.70	1.00
Legend for warning signs 1- black 2- yellow 3- black				

Figure 1: Dimensions of the safety zones in the shaft head [Source: DIN EN 81-20, Table 3]

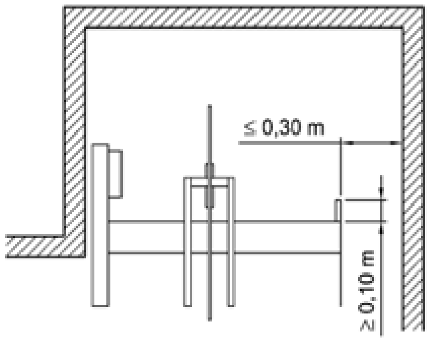


Legend

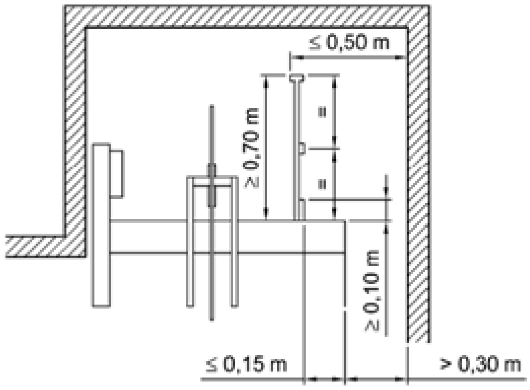
A	Clearance ≥ 0.50 m (5.2.5.7.2 a))
B	Clearance ≥ 0.50 m (5.2.5.7.2 a))
C	Clearance ≥ 0.50 m (5.2.5.7.2 c) 2))
D	Clearance ≥ 0.30 m (5.2.5.7.2 c) 1))
E	Clearance ≤ 0.40 m (5.2.5.7.2 c) 1))
F	Highest parts installed on the lift car roof
G	Lift car
H	Safety zone

Figure 2: Minimum distances between the parts mounted on the lift car roof and the lowest parts mounted on the shaft ceiling [Source: DIN EN 81-20]

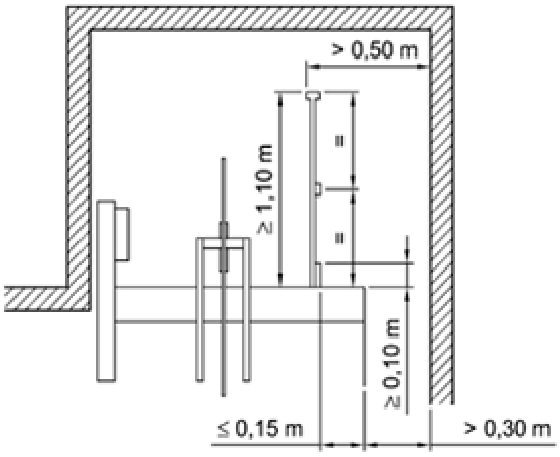
3.2 Balustrades



No railings required
but baseboard required with a min. height of 100 mm



Railings required, min. height 700 mm
and a baseboard, min. height 100 mm



Railings required, min. height 100 mm
and a baseboard, min. height 100 mm

Figure 3: Balustrades on the lift car roof – height [Source: DIN EN 81-20]

3.3 Device for Bridging the Shaft and Lift Car Door Contacts

Electrical bridging option on the control panel or the emergency and test panel:

- Protected against unintentional actuation
- Labelled "Bypass" or with an icon
- Clear identification of activation state

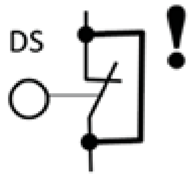


Figure 4: Bridging switch sign [Source: DIN EN 81-20]

Functional requirements:

- Eliminates normal control
- Must be a way to bridge the door and latch contacts from the shaft hatch and lift car doors
- No simultaneous bridging of lift car and shaft hatch contacts
- Driving operation only with service or recall control
- Audible alarm [55 dB (A) at a distance of 1m] in the lift car and flashing light under the lift car

Figure 5: Flashing light with audible alarm

3.4 Second Service Control Device for Shaft Pit

There must be a service control system in the shaft pit.

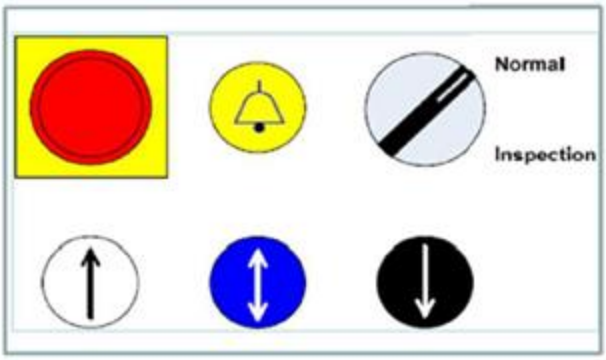


Figure 6: Service control device

Control elements:

- Switch
- Directional buttons "UP" (white) and "DOWN" (black)
- Control button: BLUE, protected against unintentional actuation
- Simultaneous, one-handed actuation of direction and travel buttons
- Emergency stop switch
- Device to prevent the stationary part of dials from twisting

3.5 Lighting (Shaft – Lift Car / Emergency Lighting)

Shaft:

- Min. 50 lux at a height of 1 m above the lift car roof and above the shaft pit
- 20 lux in the rest of shaft
- Sufficient number of lighting fixtures in the shaft and, if necessary, additional lighting on the lift car roof
- Additional (mobile) lighting for any special tasks required

Lift car:

- Normal 100 lux (on controls + 1 m above ground)
- Emergency lighting 5 lux (on alarm trigger device + centre of lift car and lift car roof at a height of 1 m)

3.6 Ladder

Ladder requirements:

- Maximum weight of moveable ladders 15 kg
- Movable ladders must be secured in the threshold and pit to prevent slipping and tipping over
- Distance from rungs to the wall min. 200 mm for vertical ladders
- Distance from threshold to movable ladder in storage position max. 800 mm

- Distance from threshold to rung centre max. 600 mm to disembark
- Electrical monitoring of the storage position for movable ladders that protrude into the lift shaft

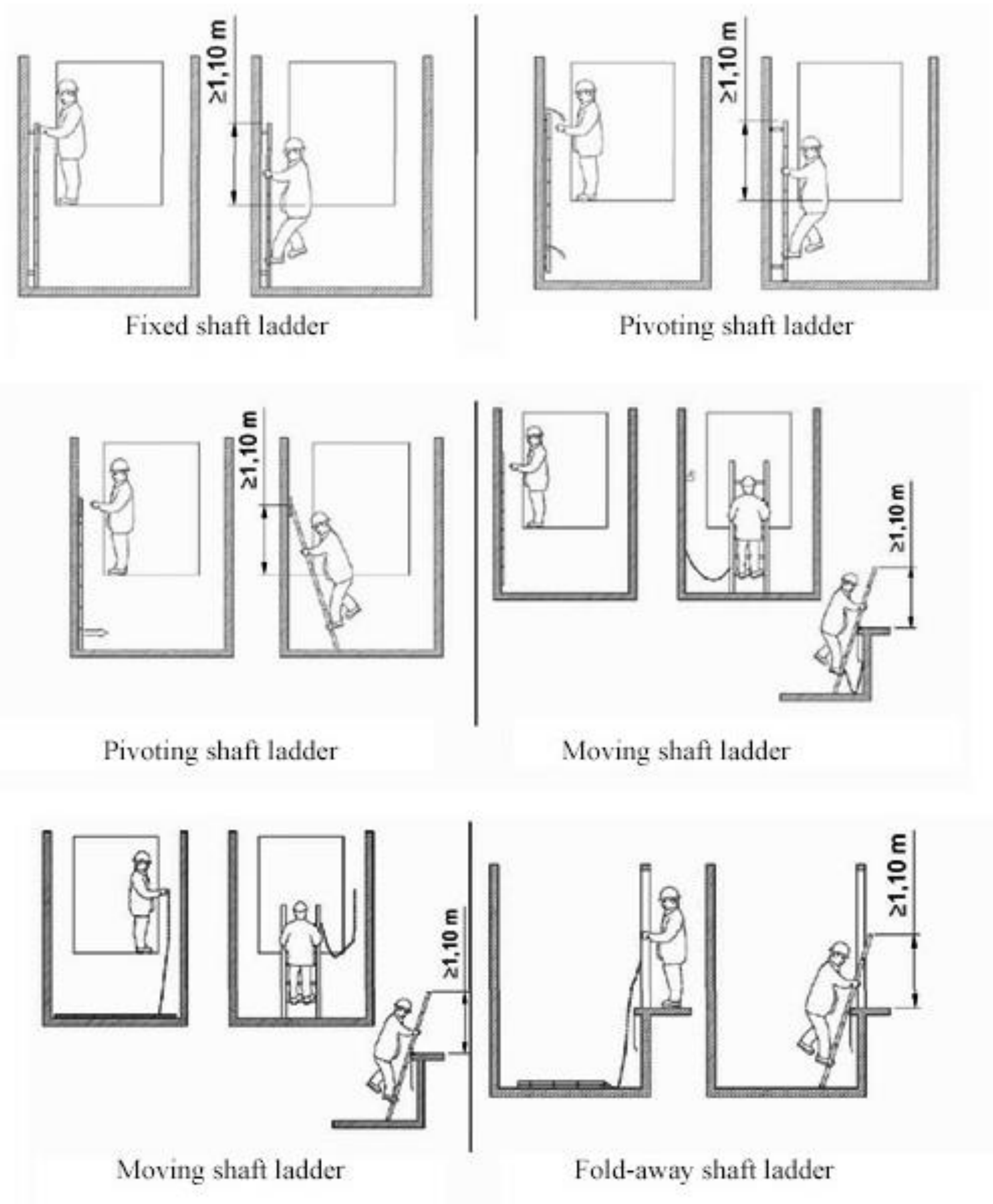


Figure 7: Types of shaft pit ladders [Source: DIN EN 81-20]

4 IMPLEMENTING INNOVATIVE LIFT SYSTEMS BY MEANS OF RISK ASSESSMENT

4.1 Drivers of Lift Design Innovations

In the last 30 years, innovation in lift design was driven by some key targets:

1. Maximising safety of users during lift standard operation safety of technicians and during installation and maintenance activities
2. Reducing pit depth
3. Reducing headroom height
4. Maximising car surface vs shaft dimensions by reducing dimensions of shaft components or eliminate them altogether
5. Combining existing components into logical modules that can perform differently according to different system status (i.e. UCM solutions – Unintended Car Movement)

4.2 Depicting Innovation

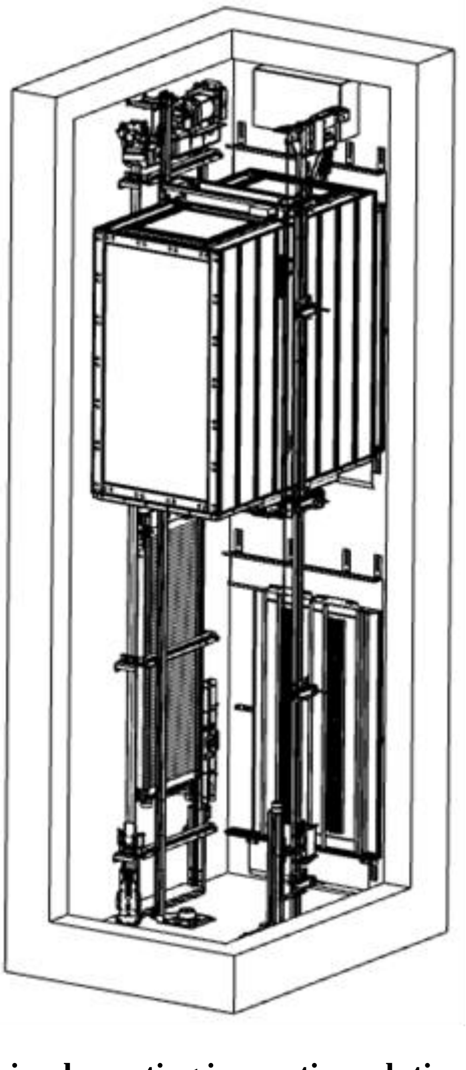


Figure 8: 3D view of a lift implementing innovative solutions in line with EN81-20/50 requirements

Figure 8 shows a lift system incorporating some innovative solutions in line with market requirements. In particular, it features:

- Introduction of a PESSRAL system
  → No mechanical limit switches
  → No mechanical service limit switches
  → Integrated door zone bridging
  → Integrated UCM solution
- Use of a magnetic strip-based absolute positioning system
- Use of mechatronic safety gear

4.3 Introduction of PESSRAL System

PESSRAL

Programmable Electronic Systems in Safety Related Applications for Lifts

In the elevator industry, today more and more systems are comprised out of electrical and/or electronic elements, which are used to perform safety functions in lifts (see operating modes below). The new EN 81-20 standard contributes by defining SIL (Safety Integrity Level) requirements for safety functions. These kinds of systems require a totally different approach compared to the development for a conventional safety system.

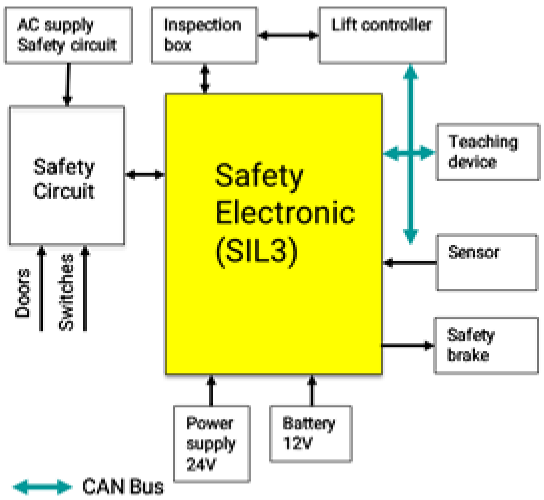


Figure 9: Safety electronics

Examples of safety functions/operating modes performed by electronic elements

- Pre-commissioning
  → Open safety circuit
  → Drive only with call-back control

- Teach-in
  → Door zones
  → Calculation of end positions

- Normal mode

→ Excessive speed detection
→ Open safety circuit
→ Activating the Safety Gear

4.4 Magnetic Strip-Based Absolute System: Main Characteristics

Magnetic tape technology has significant advantages over alternative measuring methods of the car position in the shaft. Contaminations that typically occur in the lift shaft, like dirt, moisture and even smoke do not affect the measurement result - a significant safety advantage over optical systems.

- Impervious to dirt, smoke, moisture and high temperatures
- High transport speeds of up to 10 m/s
- High accuracy and reproducibility
- Absolute location always available
  → No teach-in trips or reference procedures even after long power outages

- Practically wear-free – almost zero mechanical stress
- Significantly reduced number of parts in the shaft
- Savings in assembly and maintenance

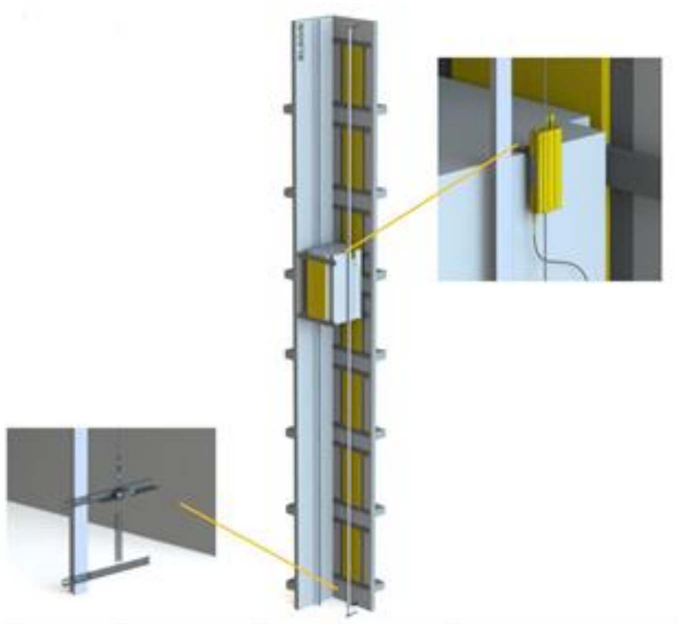


Figure 10: Magnetic strip-based absolute position system [1]

Future-oriented

- Conventional overspeed governor and tension weights can be replaced
- Option for automated trigger of electro mechanical safety gear
- Remote monitoring of safety components via the lift control system

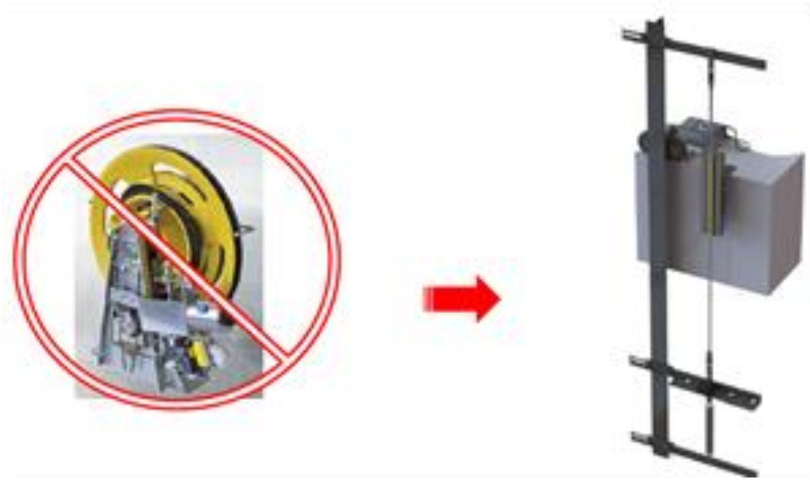


Figure 11: Mechanical Overspeed Governor replaced with electromechanical trigger system [1]

5 FROM CURRENT IMPLEMENTATIONS TO INNOVATIVE MECHATRONIC SAFETY GEAR

5.1 Current Typical Lift Model Implementation

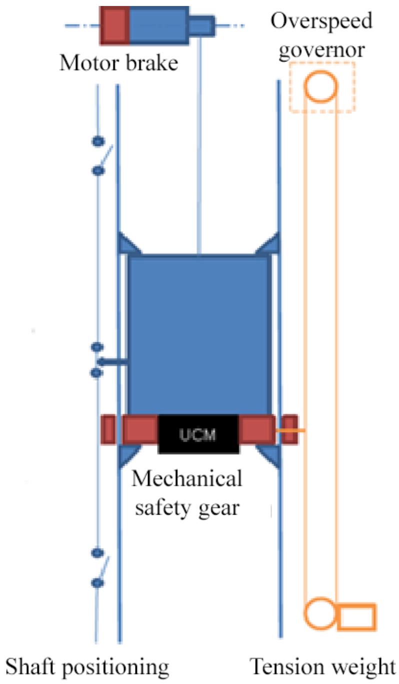


Figure 12: Typical safety gear system

The current typical market implementation of the safety system in a lift, although highly reliable, relies on a quantity of sub-components that take valuable shaft space and are subject to wear and tear:

- Safety gear assemblies
- Mechanical synchronisation of safety gear
- Overspeed Governor

- Tension weight
- Overspeed governor rope
- ... and its connection to the safety gear synchronisation on the lift car

Disadvantages

- Several components used to provide the safety solution, all must function as a compatible system to ensure correct activation
- Sub-optimal shaft utilization
- Reliability (many components, more potential for malfunction, mechanical interfaces are prone to wear and contamination from debris, lubrication build up etc.)
- Accuracy (tripping can happen at potentially dangerous speeds due to mechanical activation in pre-determined points of the over-speed governor wheel)

5.2 Mechatronic Safety Gear System

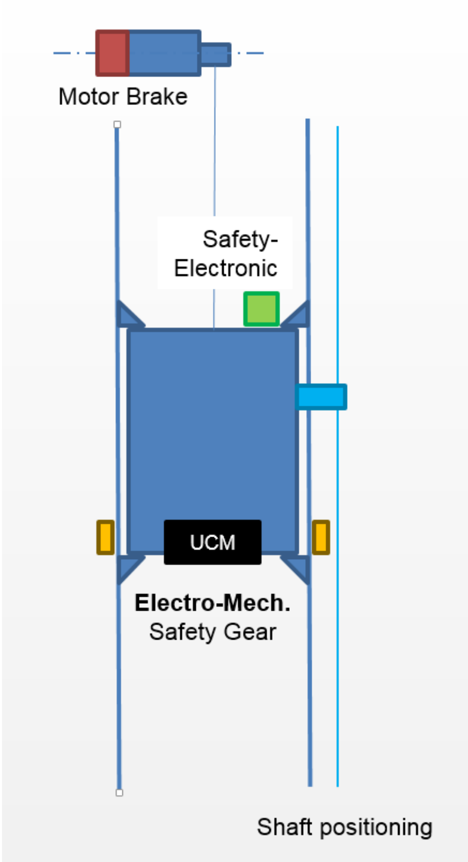


Figure 13: Mechatronic safety gear system

The use of an absolute positioning system opens the way to the adoption of a new type of electromechanical safety gear. A mechatronic safety gear is kept in standby mode by a retention electromagnet. Tripping is deployed by an electrical signal that turns the electromagnet off, thereby freeing an activation spring that performs a mechanical activation of the safety gear.

Synchronisation among additional braking components is electrically performed.

Fewer components

- Mechanical synchronisation of safety gear
- Overspeed Governor
- Tension weight
- Overspeed governor rope
- … and its connection to synchronization

New components

- Sensors (SILx) – shaft positioning
- Safety electronics
- UPS (Uninterruptable Power Supply)

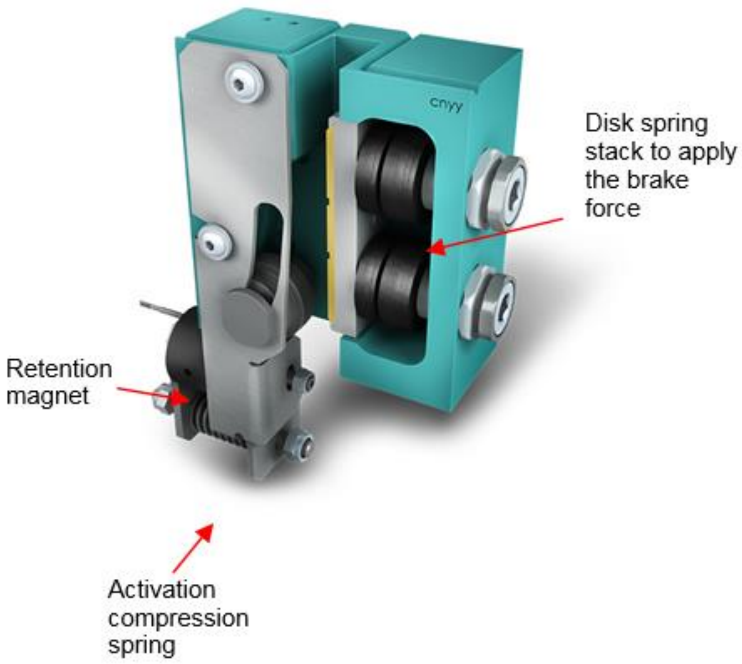


Figure 14: Mechatronic safety gear

Advantages

- Less components in the shaft
- More space for the cabin inside the same shaft
- Faster activation can be achieved compared to mechanical activation, overspeed conditions could even be detected before they reached critical activation.
- Easy synchronisation between multiple units open the way to new and optimised design for car slings
- Easy integration in a complete UCM solution against uncontrolled car movement when open at a landing, no additional control modules or electronic monitors on overspeed governors required.
- Easy connection to remote cloud-based monitoring systems for smart maintenance and general speed monitoring (acceleration/deceleration rates)

To be considered

- UPS must be installed and periodically inspected for efficiency to guarantee the correct operations in case of power failure.
- Correct installation and testing of this innovative sub-system required, more demanding on installation technical resources.

6 CHALLENGES TO COPE WITH INCREASING LIFT COMPLEXITY

New requirements introduced by EN81-20/50 as shown in the first part of this paper are increasing the complexity of the design stage of a new lift, as new measurements must be taken into account and choices of equipment are driven by the actual measurements of each shaft.

The best way to cope with the increasing complexity is to deploy a full 3D design workflow. Although this might draw some extra resources in the planning stage, experience documented by design manufacturers proves that the extra effort is more than rewarded in the long run. For example, production of required documentation and extra documentation for the installation becomes straightforward. Moreover, experience in designing EN81-20/50 systems in 3D will progressively become a company asset in form of re-usable 3D drawing templates.

Moreover, working with 3D models of the complete lift is the easiest way to take the most advantage from the new arrangement of mechatronic safety gears and reclaim the extra space for the car. 3D design makes it easier to work out solutions to accommodate larger cars that could not possibly be inserted in a traditional system with mechanical activation and synchronisation of safety gears. The availability of standard models for the next generation of safety gears and car slings is surely going to make the redesign easier in the near future.

7 CONCLUSIONS

The enforcement of EN 81-20/50:2014 is another step in the process of continuous improvement of safety and comfort in the standard use of lifts and in the installation and maintenance activities involved in its lifecycle.

New possibilities arise in the implementation of lift design, mostly connected to the use of sophisticated electronics, which have reached a suitable reliability degree for lift implementation. PESSRAL systems simplify approach to a number of safety topics connected to the lift system.

Absolute positioning systems have led the way to the adoption of a new generation of safety gear that, when combined with a magnetic strip-based absolute positioning system including safe electronic actuation, do not require a conventional over-speed governor and its tension weight: easy synchronisation of multiple safety gears, fewer components in the shaft, and more space available for the cabin.

To cope with the added complexity brought about by the introduction of EN81-20/50 and to be able to make the most out of the new possible safety gears arrangement, it is advisable to deploy complete 3D design workflow for each new lift project to reclaim the extra space available and install larger car in a shaft that could not traditionally host them.

Correct deploying of mechatronic safety systems requires an UPS to overcome power failures and demands on the installation technicians. However, it also has the advantage of being ready for the next generation of remote monitoring systems that have recently been introduced on the market.

REFERENCES

[1] ELGO Electronic GmbH & Co. KG https://www.elgo.de/

BIOGRAPHICAL DETAILS

Dennis Major has worked in the UK Lift industry for 38 years; he has collected a wide range of experience in the UK & European lift industry in a number of different technical and commercial positions before joining Wittur Ltd, a subsidiary of Wittur Group in 2010, becoming Managing Director in 2014. He current works as a freelance technology and business development consultant that he also combines with his specialist field of lift rope application, inspection, training and investigation.