Why Escalators Require Safety Gear Similar to Lifts

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Abstract. As outlined in European standards, safety gear (commonly referred to as "parachutes") is mandatory for lift cabins where uncontrolled descent is possible but required for escalators under three specific conditions, particularly when the escalator height exceeds 6 meters. This study begins by examining the historical development of parachutes, lift safety regulations, and the requirements established by European standards. It then analyses escalator incidents where the primary braking system failed to stop the escalator, highlighting the necessity of auxiliary brakes even for escalators under 6 meters in height. Finally, the research advocates for making auxiliary brakes mandatory across all escalators. By equipping escalators with safety mechanisms similar to those in passenger lifts, a secondary system can effectively prevent accidents, significantly enhancing passenger safety.

1 INTRODUCTION

The history of parachutes dates back to the 18th and 19th centuries. Initially, parachutes were used to reduce the speed of falling balloons, aeroplanes, etc., and sometimes they were used for recreational purposes.

1.1 Parachutes in lifts

After the invention of the lift safety brake by Elisha Otis, it was also called a parachute in lifts. However, just as a parachute includes components such as the pilot chute, bridle, apex, canopy, skirt, suspension lines, links, risers, control lines, harness and container, bag, and manual activator mechanism, the parachute in a lift also does not mean only the safety brake. It includes the governor, tension sheave, governor wire rope, rope clamp, governor engagement microswitch, safety brake engagement microswitch, safety brake, synchronisation lever, etc., which ultimately create safety similar to an aeroplane parachute for the lift. With this definition, an upward parachute does not make sense; rather, the correct term is the safety mechanism to prevent upward overspeed or upward safety brake. Installing a parachute is mandatory for all passenger cabins and, under certain conditions, for the counterweight as well.

Figure 1 Conceptual photo of a parachute in an elevator

1.2 Parachute requirement in escalators

Unlike lifts, the parachute mechanism for preventing passenger accidents is not mandated for escalators under EN115-1:2017 [1]. According to sub-clause 5.4.2.2.1 of the standard, auxiliary brakes (similar to parachutes in lifts) are only mandatory under three conditions:

a) the connection between the operational brake and the driving sprockets is not accomplished by shafts, gear wheels, multiplex chains, or more than one single chain, or
b) the operational brake is not electro-mechanical, or
c) the escalator rise exceeds 6 meters.

Figure 2 Conceptual photo of a parachute in an escalator

1.3 Naming of escalator parachutes

Since parachutes are not always mandatory in escalators, they are called “auxiliary brake” in the standard. Therefore, the term "safety brake", which is sometimes used, is incorrect because if this component is not installed (which is optional for heights less than 6 meters), the escalator is not safe, which contradicts the standard's interpretation.

2 SAFETY BRAKE REQUIREMENTS IN STANDARDS

2.1 When should the escalator parachute operate in EN115-1?

As outlined in sub-clause 5.4.2.3 of the EN standard, the parachute system operates in two scenarios:

- Protection against excessive speed
- Unintentional reversal of the direction of travel

While the standard mandates parachute activation in these cases, sub-clause 5.4.2.2.1 specifies that auxiliary brakes are required only under three specific conditions. Given that chains and electro-mechanical brakes are used in approximately 90% of escalator designs, does the standard suggest that only escalators with a rise exceeding 6 meters pose a safety risk necessitating auxiliary brakes?

Would an escalator with a rise of 5.95 meters not also be susceptible to overspeed or unintended reversal?

If a height above 6 meters is deemed hazardous, it stands to reason that an escalator just below this threshold would share similar risks.

Figure 3 A simulated image depicting loss of balance due to a sudden change of direction

3 CONCEPTUAL CONTRADICTION IN THE STANDARD

3.1 Accidents of overspeed and unintended direction reversal

According to sub-clauses 5.12.2.7.2 and 5.12.2.7.3: A device shall be provided to detect excessive speed before the speed exceeds a value of 1.2 times the nominal speed. If unintentional reversal of direction of travel occurs, a device shall detect it immediately.

Table 8 of EN 115-1:2017 identifies both direction reversal and overspeed as hazardous conditions, necessitating intervention. In addition to completely shutting down the equipment, a skilled technician must investigate the cause. These incidents may occur in escalators of any height, from the smallest model at 0.83 meters to systems as tall as 6 meters. However, the only mandated response mechanism remains cutting off motor power and engaging the mechanical brake.

3.2 Causes of overspeed and unintended direction reversal accidents

An analysis of multiple accident cases reveals that the most common and significant causes of these incidents are:

a) Main chain failure – In most cases, the brake is integrated into the motor, and chain breakage results in the inability to support the escalator steps.

Figure 4 Main chain breakage

b) Sprocket failure or chain derailment – The breaking of the sprocket or the main chain slipping off its intended path.

Figure 5 Simulation of sprocket failure by broken teeth

c) Step chain failure (breakage or derailment) – Step chains breaking or falling off the sprocket, disrupting the escalator's operation.

Figure 6 Step chain

d) Main brake failure – Issues such as brake pad wear, oil contamination, or brake disc malfunction that impair the braking system.

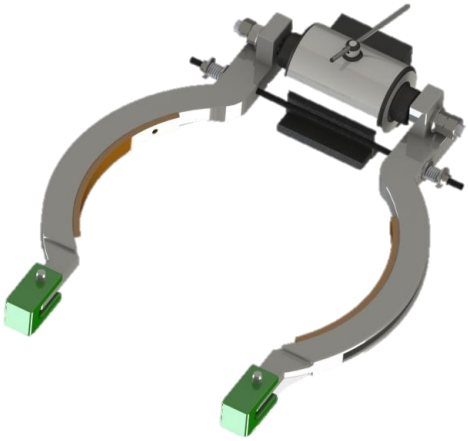

Figure 7 Main brake failure

e) Flange failure – In certain motor designs, flanges are used to prevent gearbox damage from affecting the motor shaft and to facilitate part replacement. In one documented accident, flange breakage was directly responsible for failure. Notably, in 90% of cases, the main brake is mounted on the motor. Consequently, flange breakage can lead to gearbox disengagement, rendering the main brake ineffective in stopping the system.

Figure 8 Flange breakage

f) Gearbox failure – shaft or gear

Figure 9 Gearbox breakage

3.3 When should the escalator parachute operate in ASME A17.1?

In version 2019, clause 6.1.5.3.2 [2]: If the escalator driving-machine brake is separated from the main driveshaft by a chain used to connect the driving machine to the main driveshaft, either

a) A mechanically applied or permanent magnet brake capable of stopping and holding a down-running escalator with brake rated load shall be provided on the main driveshaft, or
b) Multiple and separate chains, each with an individual drive-chain device in accordance with 6.1.6.3.4 and each with connection to the escalator driving-machine brake(s) and/or other brake(s) with capacity capable of stopping and holding a down-running escalator with brake rated load, shall be provided.

Figure 10 A simulated image depicting loss of balance due to the overspeed of the escalator

In the American standard, auxiliary braking is required even for moving walkways, but in the European standard, it is only for those over 6 meters, and 90% of conventional moving walkways have a lower height.

In version 2010, clause 6.1.5.3.2 [3]: Main drive shaft brake. If the escalator driving-machine brake is separated from the main drive shaft by a chain used to connect the driving machine to the main drive shaft, a mechanically or magnetically applied brake capable of stopping a down-running escalator with brake rated load (see 6.1.3.9.3) shall be provided on the main drive shaft. If the brake is magnetically applied, a ceramic permanent magnet shall be used.

3.4 When should the escalator parachute operate in the Japanese code?

In MOC-N (No.1424–2000): The escalator shall be provided with the following safety devices and shall be stopped depending on the detection of the operation of these safety devices.

The step chain safety device stops the escalator rapidly and surely when the step chain stretches excessively or breaks.

Although not stipulated in this regulation, for escalators that use the chain (called the main drive chain) to transmit the driving force from the driving machine to the step chain sprocket, it is required to furnish the escalator with the mechanical brake to prevent the step from descending and the safety switch to stop the driving motor when the main drive chain brakes.

In this case, it needs to rapidly stop the stopping distance of the escalators allowed to over the value obtained by the formula described in the item.

3.5 Identifying root causes of overspeed and reversal in escalators: a complex challenge

Numerous reports indicate accidents where even auxiliary brakes have failed to function with full reliability. Moreover, detecting issues such as an increase in the length of the main chain and step chain requires highly specialised measurement techniques, while structural failures like flange breakage or cracks in the brake arm often go unnoticed.

4 CONCLUSION

A technical standard is typically a defined set of requirements, so why does it incorporate recommendations when addressing critical safety matters? (refers to [1] Annexe H, part H.2 “it is recommended to install auxiliary brakes also for rises h_{13} less than 6 m.”)

Given that auxiliary brakes could be mandated for all escalators at a minimal cost (just as they are for passenger lift cabins), it stands to reason that all escalators should be equipped with parachutes (secondary brakes), similar to the ASME standard. Implementing this measure would ensure a secondary safety mechanism is always available to prevent accidents and enhance passenger protection.

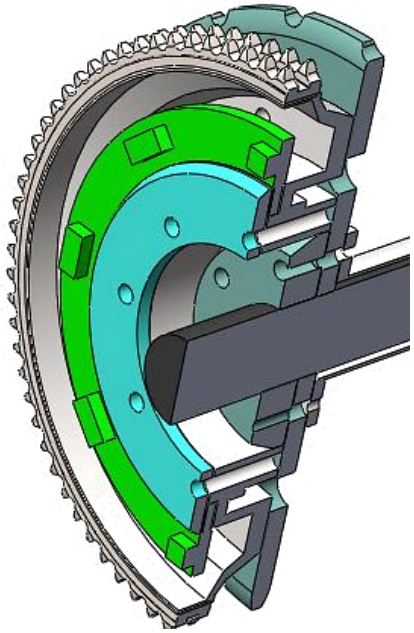

Figure 11 Schematic parts of a usual auxiliary brake

It must also be emphasised that, unfortunately, the recommendation for mandatory use of auxiliary braking systems in all escalators – a conclusion also drawn in other studies presented at the 10th and 12th Lift and Escalator Symposiums (such as [5] and [6]) – has still not been formally adopted, even after five years. It is hoped that, through the convergence of expert opinions, we will eventually reach a point where the inclusion of a secondary stopping mechanism for escalators, under all conditions, becomes a mandatory requirement in official standards.

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BIOGRAPHICAL DETAILS

Anthony Andon, a graduate in Industrial Engineering, began his career in the Lift and escalator industry in 2010.

Among his many accomplishments, Andon has authored 12 specialised books on Lifts and escalators, one of which was published by the prestigious Lift World Press in the USA. In addition, he has delivered over 145,000 hours of advanced training, served on multiple standardisation committees, and presented at numerous safety seminars.

Building on these achievements, his robust research background and success in obtaining official certification as a standardisation expert have enabled him to serve as a consultant and inspector. To date, he has applied his expertise to more than 624 escalators and 45 Lifts.