When is a Lift not a Lift?

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Abstract.
Over the last 10 years many types of lifting devices found in buildings have started to look and act the same. This blurring of products has implications for suitability, safety and equipment reliability - particularly where the underlying driver for this is cost. This paper examines the types of devices available, the standards which should apply to their design, manufacture and installation and proposes guidelines to the recommended selection criteria for each type of device.

1 INTRODUCTION

Industry outsiders often mistake the complex array of vertical transportation equipment currently available. Lifting Platforms, Goods Hoists, Slow speed lifts are widely seen as all being just lifts. Those within the industry are, however, aware of the different standards [1] applicable to different classes of devices and the performance and limitations of those devices. It is perhaps a useful exercise therefore, to examine how, why and when, this confusing situation arose. We will then also consider the scope of suitability of application of each different member in the vertical transportation family and thus help avoid outcomes which can range from user disappointment to fatal critical failures.

2 A HISTORY OF VERICAL TRANSPORTATION

2.1 From Ancient Greece to New York City

If we accept as a starting point, the definition of a lift as, “a carrier that can move people and objects up and down”, then the history of lifts is a long one. Rudimentary lifts are known to have been in use in ancient Greece as far back as 266 B.C., with the first reference of one built by Archimedes.

These early lifts had open carriers rather than enclosed ones and consisted of a carrier with a mechanism that would enable the carrier to move vertically or up inclines. These hoists were typically worked manually, either by people or animals - though sometimes water wheels were used. The Egyptians, Greeks and Romans continued to use these simple lifts for many years, usually to move water, building materials, or other heavy items from one place to another.

Henry VIII had a simple early type of stairlift installed in Whitehall castle in the 16th century. The device was powered by servants using a block and tackle system borrowed from the Navy to pull a throne up a ramp laid over 20 steps.

Dedicated vertical passenger lifts were created in the 18th century, with one of the first used by King Louis XV in 1743. He had a lift constructed at Versailles that would carry him from his apartments on the first floor to his mistress' apartments on the second floor. This lift was not much more technologically advanced than those used in Rome. To make it work, men stationed in a chimney pulled on the ropes. It was known as the "flying chair."

It wasn't until the 1800s that lift technology really started to advance. In 1823, two British architects Burton and Hormer built a steam-powered "ascending room" to take tourists up to a platform for a view of London. Several years later, their invention was expanded upon by architects Frost and Stutt, who added a belt and counterweight to the steam power.

Soon after, hydraulic systems began to be created as well, using water pressure to raise and lower the lifts carrier. This, however, was not practical in some cases - pits had to be dug below the lifts shaft to enable the piston to pull back. The higher the lifts went, the deeper the pit had to be. Thus, this wasn't a viable option for taller buildings in big cities.

Despite the hydraulic systems being somewhat safer than steam-powered/cabled lifts, the steam powered ones, with cables and counterweights, stuck around. They had just one major drawback: the cables could snap, and sometimes did, which sent the lifts plummeting to the bottom of the shaft, killing passengers and damaging building materials or other items being transported.

In 1853 Elisha Otis, with the invention of his safety brake, mitigated the risks associated with rope failure and made passenger lifts and skyscrapers the reality they are today. Thus, human ingenuity in devising and improving a transportation system called lifts, has shaped not only how we live and work, but where we live and work.

In the high-rise world, few would disagree that lifts are essential and only the right capacity, number and speed of lifts will provide an adequate transportation system. This however is largely true of all types of buildings.

2.2 The evolution of the definition of lifts and other types of lifting devices.

The starting definition of a lift as a carrier that can move people and objects up and down, was broadly based and with the invention of cranes and other lifting devices and so it was inevitable that a clearer definition was required. It is beyond the scope of this paper to examine all the changes in accepted definitions, but it is important to demonstrate the differences cited in various documents over the last 30 years: -

- In BS 5655-2 1988, EN81-2 1987 a lift is defined as "*permanent lifting equipment serving defined landing levels, comprising a car whose dimensions and means of construction clearly permit the access of persons; running at least partially between rigid vertical guides or guides whose inclination to the vertical is less than 15 degrees".*

  SI 831 The Lifts Regulations 1997 defines a lift as *"an appliance serving specific levels, having a car moving:*

(a) Along guides which are rigid; or

(b) Along a fixed course or along a fixed course even where it does not move along guides which are rigid (for example a scissor lift), and inclined at an angel of more than 15 degrees to the horizontal and intended for the transport of:

- *Persons*

- *Persons and goods*

*Goods alone that is to say, a person may enter it without difficulty, and fitted with controls situated inside the car or within reach of a person inside."*In EN 81-2 1998 the inclusion of a definition was removed but the scope stated *"1.1 permanent installed new hydraulic lifts serving defined landing levels having a car designed for persons or persons and goods, suspended by jacks, ropes or chains and moving between guide rails inclined not more than 15 degrees to the vertical".*The statements of additional requirements in 1.2 and exclusions in 1.3 of the scope are the precursors for the development of new standards or the revision of existing standards. This in 2014 therefore, formalised a process where the changes in the scope of one standard, opened the door for the development of another standard. A process which began in the late 20th Century and has become the EN81 family of standards. By 2025 the whole family will migrate into the ISO 8100 family of

world standards for lifts. There is of course a lot of work to be done to get to this position as all draft standards will have to be completed and agreed at a global level.

Standards covering other types of lifting devices, also use the scope of the standard, as a means of providing a definition of the device:

- Service Lifts EN81-3

"1.1 This standard specifies the safety rules for the construction and installation of permanently installed new electric service lifts with traction or positive drive, or hydraulic service lifts defined as lifting equipment, serving defined landing levels, having a car, the interior of which is regarded as inaccessible to persons on account of its dimensions and means of construction, suspended by ropes or chains or supported by a ram and moving between rigid vertical guide rails or guide rails whose inclination to the vertical does not exceed 15° and driven electrically or hydraulically.

This standard covers service lifts with rated load not exceeding 300 kilograms and not intended to move persons."

- Accessible Goods Only Lifts EN81-31

"1.1 This European Standard applies to new electric accessible goods only lifts with traction or positive drive and new hydraulic accessible goods only lifts, permanently installed in restricted areas and/or only used by authorised and instructed persons (users), serving fixed and permanent landing levels, having a load carrying unit made of a single load carrying area, designed for the transportation of goods only, moving along a fixed path (e.g. scissor lifts, lifts with guide rails) and inclined not more than 15° to the vertical, with rated speed not exceeding 1 m/s.

This European Standard covers accessible goods only lifts with rated load exceeding 300 kg and not intended to move persons.

This standard deals with all significant hazards, hazardous situations and events with the exception of those listed in 1.3 below, relevant to accessible goods only lifts, when they are used as intended and under the conditions foreseen by the manufacturer (see Clause 4).

1.2 For the purpose of this European Standard, a goods only lift is regarded as accessible where one of the following conditions is satisfied:

a) floor area of the load carrying unit is greater than 1,0 m2;

b) depth of the load carrying unit is greater than 1,0 m;

c) height of the load carrying unit is greater than 1,20 m.

In case of a platform, it is considered accessible when the height of the landing doors is more than 1,20 m.

1.3 Two types of accessible goods only lifts are addressed:

a) Type A, where the intended use is bound to the following two simultaneous conditions:

1) maximum rated speed: 0,30 m/s;

2) maximum travelling height: 12 m;

b) Type B, where one of the conditions mentioned above is not fulfilled."

- Stairlifts EN 81-40

"1.1 This European Standard deals with safety requirements for construction, manufacturing, installation, maintenance and dismantling of electrically operated stairlifts (chair, standing platform and wheelchair platform) affixed to a building structure, moving in an inclined plane and intended for use by persons with impaired mobility:

- *travelling over a stair or an accessible inclined surface;*
- *intended for use by one person;*
- *whose carriage is directly retained and guided by a guide rail or rails;*
- *supported or sustained by rope (5.4.4), rack and pinion (5.4.5), chain (5.4.6), screw and nut (5.4.7), friction traction drive (5.4.8), and guided rope and ball (5.4.9)."*

- Lifting Platforms EN81-41

"1.1 This European Standard deals with safety requirements for construction, manufacturing, installation, maintenance and dismantling of electrically powered vertical lifting platforms affixed to a building structure intended for use by persons with impaired mobility:

- *travelling vertically between predefined levels along a guided path whose inclination to the vertical does not exceed 15°;*
- *intended for use by persons with or without a wheelchair;*
- *supported or sustained by rack and pinion, wire ropes, chains, screw and nut, friction/traction between wheels and the rail, guided chain, scissors mechanism or hydraulic jack (direct or indirect);*
- *with enclosed lift ways;*
- *with a speed not greater than 0,15 m/s;*
- *with platforms where the carrier is not completely enclosed."*

- Lifting Tables serving 2 fixed levels EN1570-1

"1.1 This European Standard specifies the safety requirements for industrial lifting tables for raising and/or lowering goods and the operator(s): — where the lifting table does not pass a fixed landing; — serving not more than 2 fixed landings.

1.2 This European Standard deals with all significant hazards pertinent to lifting tables when they are used as intended by the operating instructions and under the conditions foreseen (including foreseeable misuse) with the operating instructions (see Clause 4). This European Standard specifies the appropriate technical measures to eliminate or reduce the risks arising from the significant hazards.

1.3 Both power operated and manually operated lifting tables are included whether stationary or mobile.

1.4 This European Standard does not apply to the following equipment:

- *— lifting tables, serving more than 2 fixed landings of a building, for lifting goods with a vertical travel speed not exceeding 0,15 m/s (EN 1570-2);*

— lifting tables, serving more than 2 fixed landings of a building for lifting operators, with a vertical travel speed not exceeding 0,15 m/s (EN 1570-3);

— lifting tables carrying operators and installed in full enclosures (EN 1570-3);

— permanently and temporarily installed lifting tables, serving specific levels of a building for lifting operators, with a vertical travel speed exceeding 0,15 m/s (EN 81-1 and EN 81-2);

— lifting tables with flat or toothed belts lifting systems for the carrying of operators;

— lifting tables whose vertical travel speed exceeds 0,15 m/s (unless safe by position and non person carrying);

— power operated lifting platforms for persons with impaired mobility (EN 81-41);

— mobile lifting tables for airport ground support equipment (EN 1915-2 and EN 12312-1);

— lifting tables which are designed as part of a lift according to Directive (95/16/EC);

— lifting tables used on ships; — mobile elevating work platforms (EN 280);

— static elevating work platforms; — vehicle lifts for maintenance (EN 1493);

— mobile lifting tables used for fire fighting (EN 1777);

— mobile lifting tables used as fork lift trucks and order pickers;

— mobile lifting tables with a horizontal travelling speed of more than 1,6 m/s;

— rail dependent storage and retrieval equipment (EN 528);

— theatre stage lifts intended to move performers;

— scissor lift pallet trucks (EN ISO 3691-5);

— suspended lifting tables;

— lifting tables operated by pushing chains."

- Lifting tables serving more than 2 fixed levels EN1570-2

"1.1 This European Standard specifies the safety requirements applicable to lifting tables presenting

the following characteristics:

— serving more than two fixed landings of a construction;

— able to pass landings;

— designed exclusively for lifting or lowering goods and not persons;

— only accessible to persons during the loading/unloading phases;

— with a travel speed of no more than 0,15 m/s;

— permanently installed.

1.2 This European Standard deals with all significant hazards pertinent, with the exception of noise, to lifting tables when used as intended and under the conditions foreseen by the manufacturer (see Clause 4). This European Standard specifies the appropriate technical measures for eliminating and reducing the risks arising from the significant hazards.

1.3 This European Standard does not apply to the following equipment:

— permanently installed lifting tables, serving specific levels of a construction, with a vertical travel speed exceeding 0,15 m/s (EN 81-31);

— lifting tables serving not more than two fixed landings of a construction (EN 1570-1);

— lifting tables, serving more than 2 fixed landings of a construction for lifting operators, with a vertical travel speed not exceeding 0,15 m/s;

— lifting tables carrying operators and installed in enclosures with a vertical travel speed not exceeding 0,15 m/s;

— lifting tables used on ships;

— lifting tables designed for artists and stage set features during artistic performances;

— lifting tables driven by pusher chains."

EN81-21 2018 3.1 defines an existing building as "*a building, which is used or was already used before the order for the lift was placed*" and clarifies this "*Note 1 to entry: A building whose internal structure is completely renewed is considered as a new building*". Where there is a new lift shaft constructed within an existing building which retains some of its internal structure the alternative safety measures defined in EN81-21 can be utilised.

The position set by the European Commission's Lift Committee 0n 9th September 2004 [2] and used by HSE guidance in the UK is that any lift in an existing lift shaft would be classed as a new lift if only the guide rails or the guide rail fixings were retained. This may in time have major ramifications for the industry. If any new lift in an existing building can offer the equivalent safety measures, outlined in EN81-21, to the traditional refuge spaces in the headroom at the top of the lift shaft and pit at its base - why can this not be the case in new buildings? New buildings can have the same unavoidable limitations on pit depth, caused say by an underground railway as the existing building next door. The only solution currently available for new lifts in a new building with restricted pit or headroom is to utilise a slow speed lift, which is currently certified under the Machinery Directive previously cited. EN81-42 will, when published, codify this type of device. It is a concern that this type of device may not be suitable for the overall requirements of the building viz. traffic handling, suitability for use as a firefighter's lift, vandal resistance, reliability and longevity.

Table 1 shows the standards which apply to various types of Vertical Transportation. Some of the standards listed are at the planning stage or are in preparation. Others refer to components common to lifts and other types of lifting devices.

Table 1: Standards for different types of Vertical Transportation and associated equipment

Type of Lift or Component	**Applicable Standard**
Electric and hydraulic service lifts	EN81-3

Lifts for the transportation of persons and goods	EN81-20
New passenger and goods passenger lifts in existing building	EN81-21
Electric lifts with inclined path	EN81-22
Remote alarm on passenger and goods passenger lifts	EN81-28
Accessible goods only lifts	EN81-31
Stairlifts and inclined lifting platforms	EN81-40
Vertical lifting platforms	EN81-41
Slow speed lifts	EN81-42
Lifts in cranes	EN81-43
Lifts in wind turbines	EN81-44
Design rules, calculations, examinations and tests of lift components	EN81-50
Type examinations of lifts	EN81-51
Landing door fire test	EN81-58
Technical file and instruction for use special lifts for persons and goods	EN81-60
Technical file and instruction for use Goods only lifts	EN81-61
Remote monitoring of lifts	EN81-68
Accessibility for persons with disability	EN81-70
Vandal resistant lifts	EN81-71
Fire fighters' lifts	EN81-72
Behavior of lifts in the event of fire	EN81-73
Lifts subject to seismic conditions	EN81-77
Improvement of safety of existing lifts	EN81-80
Modernisation of lifts	EN81-81
Accessibility improvement of existing lifts	EN81-82
Vandal resistance improvement of existing lifts	EN81-83
Escalators and Moving walks	EN115-1
Improvement of safety to existing escalators and moving walks	EN115-2
Builders hoists goods with accessible platforms	EN12158-1
Inclined hoists for goods non accessible	EN12158-2
Builders hoists for persons and goods	EN12159
Transport platforms	EN16719
Lifting tables for up to 2 landings	EN1570-1
Lifting tables for more than 2 landings	EN1570-2

2.3 Other standards for Lifts

The main types of lift missing from the above standards are:

- Evacuation Lifts formerly covered in the UK by BS5588 part 8 and now covered by BS9999 and BS9991 for evacuation lifts in residential buildings. These standards define the additional features required for lifts to be used for the evacuation of building occupiers.

- Goods only lifts with attendant control - these devices are usually manufactured as slow speed lifts and may be designed to EN81-42 once the standard is issued. They are currently manufactured to the Machinery Directive.

- Home lifts colloquially known as “Through the floor” lifts are covered by in the UK BS5900

- None enclosed or partly enclosed lifting platforms (or step lifts as they may be known colloquially) are covered in the UK by BS6440.

The format of the testing and final inspection of lifts is currently set down in the BS8486 series of standards. Other types of lifting devices such as lifting platforms, lifting tables, goods only lifts, stairlifts and home lifts do not have an equivalent set of testing and inspection documents.

3 LEARNING FROM HISTORY – SUFFICIENT SAFETY?

Lifts installed under the Lifts Directive are subject to a design and installation procedure, which is approved and monitored by a Notified Body and in the UK, are subject to a comprehensive final inspection based on the BS8486 series of standards. Devices supplied and certified under the Machinery Directive may not be as carefully selected, risk assessed, designed, installed or tested. There is a body of opinion which holds that there may not be equivalent safety in Machinery Directive Devices (when compared to lifts installed under the Lifts Directive), but there is sufficient safety. I do not hold with that body of opinion. There cannot be enough safety if there are accidents and incidents occurring. Of the LEIA safety notices issued in the last 20 years [3], over 30% have related to lifting appliances other than lifts. The HSE have reported that here have been a series of incidents involving lifting platforms with landing doors that have opened when the carrier in not at that floor [3]. There have also been instances of premature drive nut failures on lifting platforms including those designed to transport goods [3]. These types of event sadly have occurred before with tragic consequences.

3.1 Case study: The High Claire Rochdale Incident 1985

BS5900-1980 “Specification for Powered Home lifts” was intended to be a domestic home lift standard. It assumed that there would be very low usage on a device installed in a private residence and hence partly to save space (and cost), small worm wheel gear boxes with 75mm centers were utilized. Several manufacturers supplied very similar products during the early 1980’s. Sadly this type of lift started to be sold into local authority and private residential care homes, where usage was far more extensive. On 2nd September 1985, the gearbox of the lift at High Clare Rochdale, designed to BS5900, failed whilst carrying passengers. Two of the elderly passengers died from their injuries. This, much to the concern of the Health and Safety Executive (HSE), was not an isolated incident. On 11th September 1985, the Manchester Area Director wrote to all HSE Area Directors [4] advising of the issue. It was discovered that there had been several fatalities in other areas. Over the next 6 years, various modifications to Home Lifts designed to BS 5900 were attempted, aiming to prevent further accidents. None of the preventative measures applied or alternative machines supplied were able to limit the accelerated wear in the worm wheel gearboxes. Ultimately, the lifts were replaced either by hydraulic bore hole solution lifts or lifting platforms intended for a commercial application. One of the last of this type of home lift was replaced in Barnsley in June 2019. What lessons can history teach in this case - where a design was utilized outside of the scope of its design?

3.1.1 Lessons we can learn for the suitability of other types of lifting devices

Case specific lesson:

> The maximum number of trips per annum and starts per hour should be considered by the designer - as well as wear due to over loading, misalignment of guides, and poor maintenance. Load bearing components should have a sufficient factor of safety to allow for

these adverse factors. The design parameters for maximum number of trips per annum and starts per hour should be included in sales literature and in O & M manuals.

General lessons for other types of lifting devices:

a) Where there are open carriers and/or where hold to run controls are deployed on lifting platforms, the motor and other related components should be rated at least 30 starts per hour - as inexperienced users will often fail to maintain the momentary contact of the control and as a result the motor may have several starts in a single journey. Many screw-driven lifting platforms are rated at less than 20 starts per hour and this can lead to entrapment caused by the operation of thermal overload devices. Failure of this type of device can leave elderly or disabled passengers stuck above ground floor level until the device is repaired or alternative rescue means established.

b) The maximum travel for lifting platforms and slow speed lifts should be limited by the maximum time to destination analysed by simulation. The maximum time to destination should be less than 180 seconds in residential applications, and in commercial applications, 120 seconds. This would probably reduce the maximum travel for slow speed lifts to 9 meters in residential and 6 meters in commercial applications. Otherwise, it may be that a person with disability could argue that they were being discriminated against, due to the poor service provided by the access arrangements.

c) The vertical transportation system should be designed with an arrival rate for persons with a disability of at least 8% of the building population per 5 minutes, in both residential and commercial applications. For residential nursing homes, where the arrival rate may need to be higher, a conventional passenger goods lift should always be considered instead.

d) Lifting platforms are usually not designed to transport goods but can often be found in retail mezzanine applications and used regularly for that purpose. Using a device outside of the scope of its design is potentially dangerous. For example, a designer of a stairlift may reasonably not identify risks associated with it being used to carry liquid nitrogen. The event would be considered very unlikely, were it not for the fact that the British Compressed Gas Associations Code of Practice CP30, recommends the installation of a stairlift for that very purpose. Where goods are to be regularly carried a disabled lifting platform should not be used.

e) Lifting Platforms and Slow speed lifts should follow the same rules for the relationship of available area to rated load as defined in EN81-20.

f) The definition of rated speed should be the maximum speed in either direction of travel for all types of lifting appliances.

4 CONCLUSION

Our brief review of the history of lifts revealed “necessity is the mother of invention”. The meaning of this anonymous proverb is that innovations are chiefly driven by human need. In the construction industry, cost reduction can sometimes be the strongest necessity. Equipment supplied to internationally recognised standards, that are based on risk assessments, carried out by teams of experts in their respective field, guiding experienced designers, consistent manufacturers and competent installers and testers will be safer, more reliable and fit for purpose. They may well be more expensive than devices which have not gone through such a rigorous process. Other devices supplied by a different route may be sufficiently safe but may well fail to perform or last as the end user expects.

Just because an alternative to a conventional passenger and goods lift can be installed, does not mean that it should be installed, as it may not be suitable to handle the traffic flow of the building. “Buy cheap and buy twice” is another proverb and is based on common sense.

5 REFERENCES

[1] Standards will be referred to in this paper presented to an international audience as EN ** and ISO ** rather than BS EN **. All standards cited other than those in preparation can be found on the BSI online website:

https://shop.bsigroup.com/?utm_campaign=MS-UPD-MEMB-usonline1205-1205&utm_medium=PMAG&utm_source=UPDA&utm_content=us1205

[2] European Commission Enterprise Directorate-General Ref. Ares(2016)699730

[3] https://www.leia.co.uk/technical/product-information/

[4] VT Consult archive
https://documentcloud.adobe.com/link/track?uri=urn%3Aaaid%3Ascds%3AUS%3A332da449-86f4-4bd4-bef8-91df5c1913ca

6 BIOGRAPHICAL DETAILS

Michael Bottomley joined the lift industry in 1981. He worked for Gregson & Bell Lifts for 21 years and MovvéO (formerly Lerch Bates) for 17 years. He is currently a Lift and Escalator Consultant and Authorising Engineer for lifts with VT consult. He holds a degree, with honors, in Engineering and Marketing from the University of Huddersfield, and has over 38 years’ experience in lift engineering and lift design. In 1999 he was the second lift designer in the UK to achieve Notified Body approval under the Lifts Regulations 1997. He is an affiliate member of the Chartered Institute of Building Service Engineers (CIBSE) and is currently Vice Chairman and a Past Chairman of the CIBSE lifts group. He is a contributory Author to the 2015 edition of HTM 08-02 and is currently assisting with the 2020 edition of CIBSE Guide D.