"FITLIFT" ELEVATOR DESIGN FOR WELLS REDUCED OF TOP AND PIT CLEARANCES

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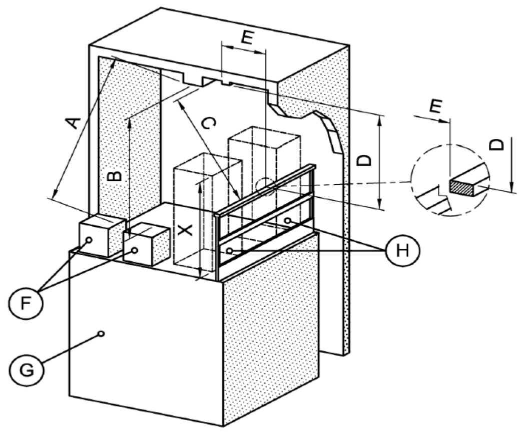
INTRODUCTION

Elevator well is designed to form safety volumes that ensure the safety of personnel during the maintenance and inspection alongside the safe operating of the elevator for normal operation. Detailed dimensions are given in the 5.2.5.7 and 5.2.5.8 articles of EN 81-20 Standard for personnel who work on the car or at the bottom of the well (pit) to have safe operating volumes. Safety dimensions for top and bottom of the well are defined with images. Balustrades on top of the car for the safety of personnel on the car are also described and their strength values are provided. Car Apron dimensions and strength values for the safe evacuation of passengers during rescue are described in the standard. All these safeguards and so forth are for ensuring the safety of users and maintenance personnel during the operation of the lift. These requirements are to be met in order for the lift to be put into service.



EN 81-20 M 5.2.5.7 Headroom safety clearances

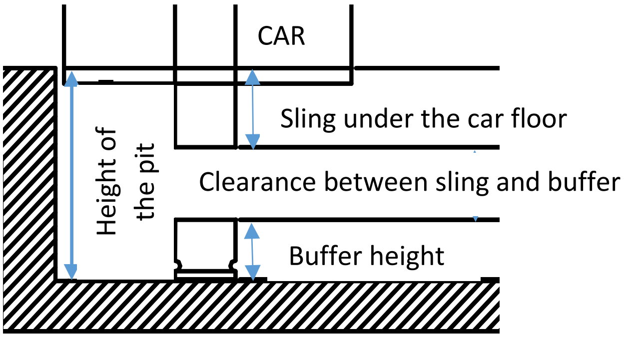
For the safety of maintenance personnel, the lift should feature pit and headroom safety volumes in addition to the normal travel range. There will not be such problem at a structure to be newly built as the dimensions will be determined according to the need. However, it is not always possible to find the required dimensions when a lift is intended to be installed in an existing structure subsequently. In this case, a separate standard is published for the lifts in wells with reduced dimensions to be installed in the existing structures. EN 81-21 Standard provides guidance about what should be considered as the risk analysis and which requirements should be performed. This article does not aim to explain the articles of EN 81-21 Standard. It aims to elaborate on the solutions of "FITLIFT" elevator designed for the requirements to be followed according to EN 81-21 Standard. A general expression on electrical circuits and mechanical installation prepared for the safety requirements demanded in the standard is purposed without elaboration specific to the company. The discoursed subjects do not meet all conditions of the Standard. However, it will give an opinion about the fundamental points to be taken into consideration.

TWO DIFFERENT OPERATING MODES OF LIFTS

We can examine the operating of lifts in two different modes. The first one is the condition of operating normal running. What is desired in this mode is that the safety components run safely and the passengers hold harmless even an unexpected movement happens within the travel limits of the lift. In the normal operating mode, safety volumes required for the maintenance personnel were not taken into consideration. In this case, it will be sufficient if there is a total height as clearance between the sling and the car buffer and a height for amounting to the car buffer We know that the clearance between the sling and the car buffer depends on the speed of the lift and if the car does not stop at the last floor, the final limit switches should be in a distance that will enable the lift to stop with engine electromechanical brake in a controlled way (electrical stop), without bumping to the buffers (mechanical stop). Mechanical stops should only take place when the lift cannot be stopped electrically in a controlled way and in comfort. This case is explained as a basic approach in "0 INTRODUCTION" section of EN 81-21 Standard.

"EN 81-21 0 Introduction……
The main concern dealt with in this standard is the reduction of top and pit clearances that may be required due to site conditions. The adopted principle of safety is based on two levels of achievement: first by means of an electrical stopping of the lift car, then by means of a mechanical stopping of the lift car."

Accordingly, there will be need for the bottom of the well with a total height of the lower part of car frame remaining under the car floor and clerance between the sling and car buffer under the floor level of a lift during normal operation. At the top of the well, there is also need for an additional headroom equal to upper part of sling over the car ceiling, counterweight buffer impact range, buffer closing height and car skip distance (half of the gravity stopping distance). These distances are the additional ranges required for the safety of the lift user for normal operating mode.



We can discuss maintenance and inspection situations as the second operating mode. In this mode, personnel can work at the pit (bottom of the well) or on the car roof. For this mode, It will be required to add safety volumes to the safe operating ranges of the lift in the first mode to prevent personnel from being cramped for space at the end of travel . Therefore, we call this operating type as safety mode. For the total range, personnel safety ranges during the maintenance works should also be added to the normal operating additional ranges. In this way, total well height required for safety of the lift is found through taking both modes into consideration. These ranges are compulsory for safety in both situations and a lift which does not meet these conditions is not allowed to be put into service.

HOW TO INSTALL A LIFT TO A BUILDING WHICH DOES NOT MEET THESE CONDITIONS?

CEN situation was examined and "**EN 81-21** Safety rules for the construction and installation of lifts - Lifts for the transport of persons and goods - Part 21: New passenger and goods passenger lifts in existing building" Standard was published for the lifts that do not satisfy the conditions specified in EN 81-20 Standard. Aim of this standard is explained in Article 1 Scope section;

"EN 81-21 Art. 1 Scope……
This European Standard covers:
- Either the construction and installation of one or more complete new lift(s) including new well and machinery spaces in an existing building; or
- The replacement of one or more existing lift(s) by new ones in existing well(s) and machinery spaces."

As can be seen in the Scope, lifts to be installed in new buildings are not included in this scope. Because these types of lifts are risky no matter how much precaution is taken and this method should not be used unless it is unavoidable. Concerning the risk reduction measures; it is stipulated that the solutions based on instructions and carefulness will not be accepted while the risk reduction measures should be activated automatically without any intervention or there should be intervention if accurate design is in question. This situation is explained in detail in Article 0 Introduction section of the standard.

"EN 81-21 Art. 0 Introduction ……
When drafting this standard, it has been considered for reduced overhead and pit the following:
a) Risk reduction measures that rely solely on operations in compliance with procedures are considered as not acceptable, except in a few situations in which mistake-proof solutions are not available (e.g. some activities in repair and installation in which safety devices cannot be operational);
b) The risk reduction measures shall be automatically (without any intervention) activated, or may be manually activated if mistake-proof-by-design, or a combination of both is used."

This standard grounds on two main points. Lift should be stopped electrically at first when there is a safety violence (controlled soft stop) and if the lift does not stop, then mechanical stop should be activated (pulsed severe stop). The second acceptance is that risk reduction measures should get activated without any need of personal intervention and even if there is a need for intervention, it should come into question after the risk-free situation is formed with this accurate design (*mistake-proof-by-design)*. When there is a risky situation, precaution should get activated and lift movement should be stopped. If there is any need for intervention, the lift should only be moved after that intervention.
I can give an example like this: If you limit the car movement through using movable buffer pedestals at the bottom of the well, firstly the lift should disengage from normal control automatically, switch to safety mode and stop (non-moving) when there is an entrance to the well and the lifts should be able to operate in revision control after the

buffer obstacles (pedestals) are removed and activated as well as the bottom or the top of the well safety is ensured. Without activating these arms, there should be no movement in the lift. Thus, a movement in the lift and the likeliness of a risk should be prevented when there is no intervention and it should not be leave up to arbitrariness to take safety precautions.

FITLIFT DESIGN MAIN PRINCIPLES

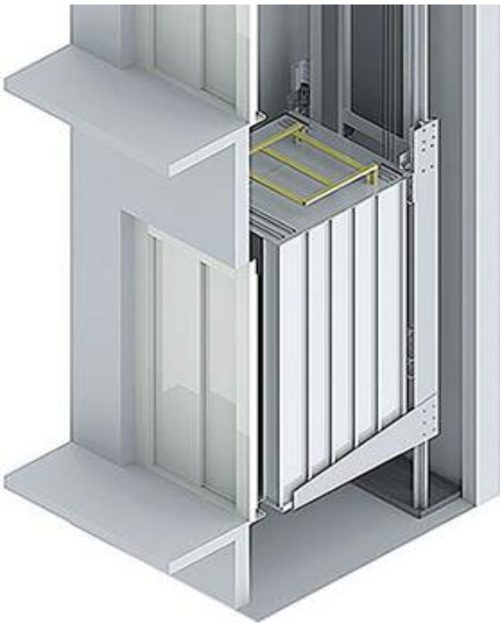
"FITLIFT" design was prepared by taking these main ideas into consideration. Operation mode was analyzed in two phases. In normal operation, solutions for the minimum well ranges that would be able to operate safely were generated. Then, a method was created to form additional safety volumes staying within these ranges in case of a switch to safety mode. Both operation mode was solved separately. We can list them as follows:

1. Car and sling heights should be pulled down to minimum dimensions and the parts of the sling that exceed the car bottom and top of should be shortened as far as possible.
2. In order to prevent additional ranges apart from the car movement, traction motor and its components as well as the bottom of the well regulator tensioning pulley and other devices should be solved within the sling clearances.
3. Car apron and balustrade should be completely foldable and should not require a separate additional range.
4. The lift should switch to safety mode automatically without need to any intervention.
5. When switched to safety mode, firstly the electrical and then the mechanical triggered stopper precautions should be taken as per requested by the standard. These precautions should create the required safety volumes at the bottom and top of the well.
6. Minimum well dimensions for the lift should be ensured through complying with the safe operation conditions in both operation mode. (Fitlift well dimensions are 18 cm (7.08 inch) for the bottom of the well as from the bottom stop threshold (as pit) and 260 cm (102.36 inch) for top of the well as from the top stop threshold.)

1. CAR AND SLING STUDY

As the car design in FITLIFT study, previously improved NESTLIFT car design was made use of. NESTLIFT is a car and sling system developed to be used in lifts featuring wells with reduced bottom clearances. This system is a L sling and the supports of L sling are taken to the side of the car as buckled sheets. Thus, it is prevented that the supports of L sling exceed under the car and that carriers under the sling increase the dimensions of the bottom of the well. The car pulls the girders here while it stands on the supporting girders in a normal L sling.

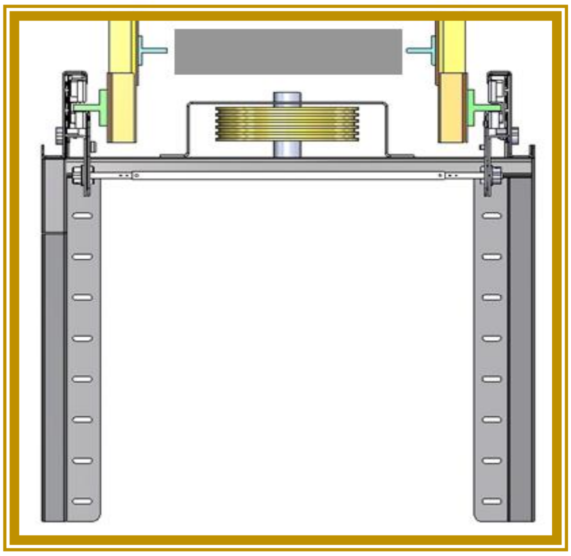
NESTLIFT car floor solved the extended car apron and sling support connection at 50 mm (1.96 inch) and is able to create a solution by fulfilling the conditions of EN 81-20 standard without any need for an additional risk analysis at a total 700 mm (27,55 inch) well bottom dimension including 80 mm (3.14 inch) buffer, 70 mm (2.75 inch) clearance between buffer and car sling and 500 mm safety volume in the lifts with a speed of 1 m/s. 500 mm (19.68 inch) safety volume protection are ensured through buffer pedestals. As buffer connections are made on L sling pillars, they stay on the side of the well while a large area is created under the car and 500 mm safety volume condition of "EN 81-20 M 5.2.5.8.1 Chart 4 Type 3" of the standard is ensured. In this car, telescopic apron is used. Foldable balustrade is provided as a solution for the lifts with reduced top clearances
Developed in 2009, NESTLIFT is a product of Yeterlift Asansör with "Utility Model Certification". Capacity increase and well bottom-top dimension certificate of compliance validity (risk analysis) was obtained on March 2015. NESTLIFT can be used as an independent product.



NESTLIFT SYSTEM OF THE CAR AND THE SLING


UYGUNLUK SERTİFİKASI
No: LD04-0309-0006-15
YETERLİFT ASANSÖR SAN. VE TİC. LTD. ŞTİ.
NESTLIFT

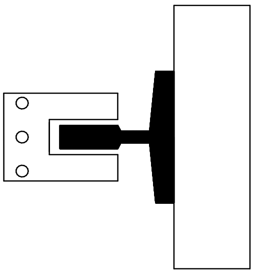
In order to use NESTLIFT in 70 cm (27.55 inch) well bottom dimensions, retarders on the last floor and limit switchers should be purchased within the package of NESTLIFT.
NESTLIFT was originally designed for lifts with reduced dimensions of well bottom and top but in conformity with EN 81-20 Standard. FITLIFT design requires different features. Additional improvements were performed on NESTLIFT car and sling for FITLIFT application. Firstly, L sling was approached to well walls in order to ensure utilization of well dimensions in full while the losses on the sides due to rail and bracket placement were eliminated. Moreover, counterweight, suspension connections and rail system were solved in a very short range behind the sling by using a group of rail system mounted on a single bracket. By this way, 70% of the well became usable for the car. Suspension system and brake connections were made suitable for FITLIFT. It is possible to install lifts with higher capacities in very small wells by means of the improved system.



FİTLİFT POSITION IN THE WELL

Emergency guidance was used for clearances between the car and devices to be minimized. Thus, clearances between the car and counterweight was decreased to 25 mm (0.98 inch) which is the lowest limit permitted by EN 81-21 standard. Emergency guidance which has no effect in normal operation prevents the car or counterweight to go off the rails when there is a breakdown in the bloc of guide shoes or tire. In this way, it hinders car and counterweight to meet with each other while it can be understood that there is a problem on guide shoes from the noise stemming from the friction.

EMERGENCY GUIDANCE



NESTLIFT car and sling system is very advantageous but it does not meet the demand of double-entry lift which is frequently seen in the lifts installed later on. In normal lifts with single-entry, even though NESTLIFT car and sling system is used, inverse L slings and cars called as “PARCEL” system were developed for double-entry lift demands. This system is able to solve car floor within 50 mm (1.96 inch) range including the apron under the car again and enables double-entry. The car is custom made and connected to the sling from the top in this system. Moreover, parcel sheet as a car cushion on the bottom side of the sling is used and car connection can be performed safely and rigidly. By this application, three sides of the car stay empty and doors can be placed on whichever side is desired.

For the slings made for Fitlift, mechanical brake connections were placed on the upper side of the sling to prevent place loss as it was in Nestlift and brake lever was operated by the help of a special mechanism. Since the upper guide shoes blocks stays under the brake connection, guide shoes block were mounted as to be dismantled from inside of the sling for the guide shoe tire change. All strength calculations of the designs were made by considering the worst conditions and the sheets in required thicknesses and fittings were used. Car and sling heights were able to be decreased to the minimum dimensions with these improved systems.

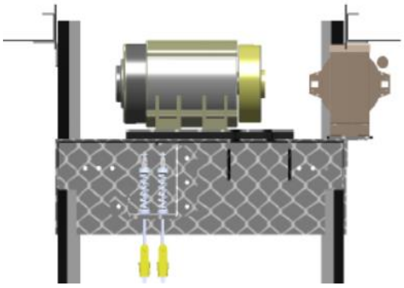
“INVERSE **L** PARCEL” SLING AND SUSPENSION MEANS

Developed in 2010, FITLIFT is a certificated and patented product with TYPE APPROVAL certificate of Yeterlift Asansör. Its first certificates were obtained in 2011.

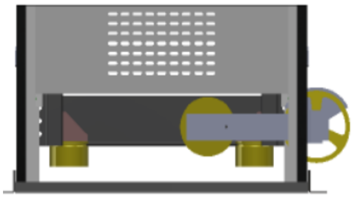
2. TRACTION, CONNECTIONS AND THEIR PLACEMENT IN WELL

As the additional ranges in well is very important for FITLIFT system, traction motor and suspension connections together with well bottom devices were solved in sling clearances of the car. For this, sling pulley connection was taken to the middle of sling and clearances were created on the bottom and top of sling. Motor and regulator system was solved in the headroom clearance while regulator tensioning pulley and buffer supports were placed in the bottom clearance. Thus, there was no need for separate ranges for these mechanisms over or under of sling movement range. Since these systems are solved in the sling clearances, there is no need for additional clearances in the well and on the sides of car. It can be seen on the image above that pulley connection is also made at the middle on the inverse L "Parcel" sling. Necessary precautions were taken by the company for this connection type not to cause tautening and friction. Besides, connection were made for dismantling and repair of the pulley. Placement at the top and bottom of the well is given in the pictures below.

IMPROVED NESTLIFT SYSTEM AND THE SUSPENSION MEANS



HEADROOM

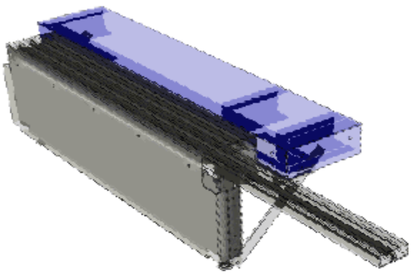


PIT

3. BALUSTRADE AND APRON

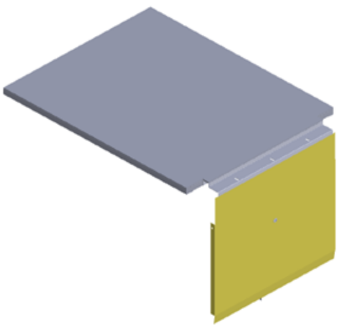
Fully foldable apron and foldable balustrade were used in Fitlift system. These mechanisms' closed and open positions are checked with electrical contacts. When the mechanisms are open, the lift does not start to operate normal running and when the car balustrade is closed, revision control movement buttons do not operate. Strength values as required by the standard are ensured in the production of these materials. In case the apron is opened, additional support system becomes involved and prevent the sheet from flexing. The hinge system of the car balustrade also provides effective strength for the balustrade. Since fully closed apron was used, there is a tripping/engagement system at the car door. Self-rescuing from the car was prevented before the apron was opened. Car door can only be opened by intervention from the outside after the apron is opened by the rescuing crew from the outside of the floor.

EXTENDED/RETRACTED APRON (FOR NESTLİFT)



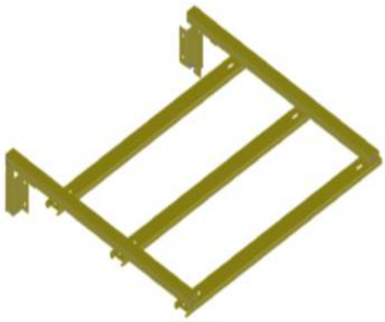
UNFOLDED/FOLDED APRON

4 cm (1.57 inch) THICKNESS AT FLOOR



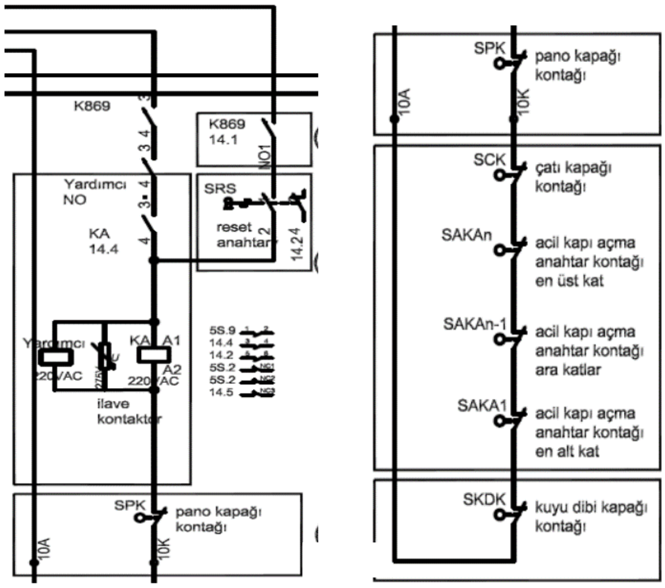
UNFOLDED/FOLDED BALUSTRADE

SWITCH CONTROLLED



4. STUDY METHOD OF SAFETY MODE

FITLIFT elevator switches to revision mode automatically when any one of the clearances opening to the well or the landing doors are opened by hands. Normal operating mode is cancelled and Safety mode operating system is activated. What is needed primarily in this mode is to check the safety volumes. When the safety mode is active, car balustrade should be opened in order for the lift to be moved. If the stopped position of the car at the bottom of the well is lower than the bottom safety clearance, the lift can only be moved to upward and if there is not top safety clearance, car can only be moved to downward with revision speed when the safety mode is activated. Creation of safety volumes was firstly taken as the basis. Thus, the operation of switching to automatic safety mode with no need for intervention as required by the standard is ensured. In case that the safety mode is activated, safety volumes necessary for the maintenance and examination personnel at the well is created. It is prevented for the lift to enter into safety volumes area again, through the precautions taken. The lift can operate in safety mode in the well only when it is not in the safety volumes.



FITLIFT SAFETY CIRCUIT FOR THE DOOR SWITCHES

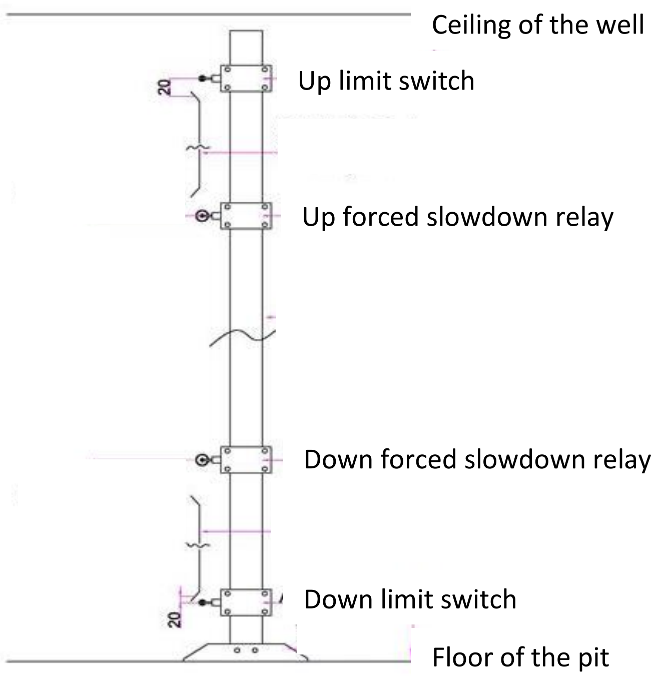
In the event of power cut in the lift, it automatically switches to safety mode since entrance to the well may happen and the lift is not released from the safety mode when the power came back on. In order for the lift to be released from the safety mode, it is required to push reset button which is placed outside the well in a way that it cannot be reached from the well. In safety mode operations, the car gives audible and light alarm when moving in the well.

5. SWITCH ARRAY IN THE WELL AND PRE-TRIGGERED STOPPING SYSTEM

FITLIFT Elevator has separate well switch placement for two different operating modes. These switches are the ones that operates through mechanical stress. Among these, the normal switch placements for normal operation are forced slowdown relay and final switches which control the approach to the lower and upper top floors. These switches operate with a forced effect and wide flats are placed across them in a way that they are not affected from the oscillations caused by unequal loading of the car (risk analysis). Their primary role is to ensure that the lift approaches to the top floors slowing down compulsorily. As the final switches, switches with very nominal activation range operating through a forced effect are used. If the lift cannot stop at the last floor, final switches are activated when the car exceeds the floor 20 mm (0.78 inch) and they switch off the circuit within 10 mm (0.39 inch) and stop the lift -which approaches by slowing down to the last stops- without an impact occurs. By this way, it is ensured that the lift operates safely with a very low dimension of well bottom. What is essential is that the lift reaches to the last floors with forced slowdown and the final switch functions in a very short range.

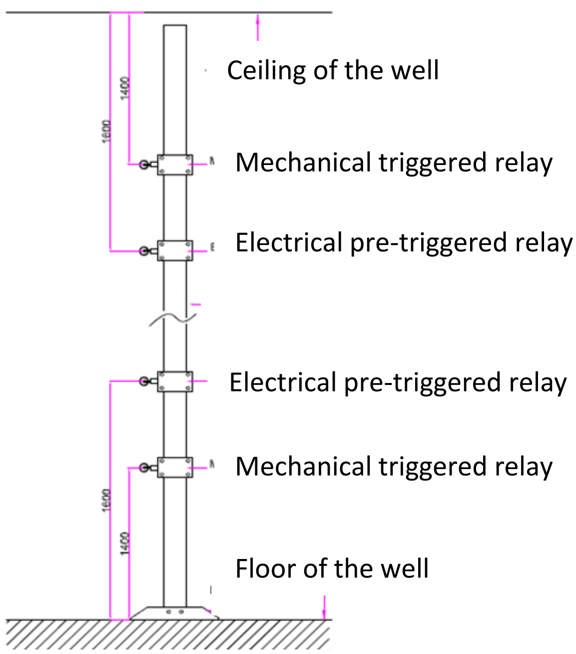
IN NORMAL OPERATION

THE POSITION OF THE RELAYS



If the lift starts to operate in safety mode, these switches are disabled and safety mode switches are activated. In this mode, the lift can only operate in revision speed. The lift's operating in safety mode is restricted with the safety mode switches. Safety volumes were created below and above these switches and if the lift approaches to these areas, firstly the pre-triggered circuit breakers switch off and stop the lift electrically by the help of electro-mechanical brake. However, if this position cannot be ensured, triggered circuit breakers placed 200 mm (7.87 inch) after this switch are activated and enable the mechanic brake of the lift. Thus, the lift is stopped mechanically through the brakes as a last resort. Even after this stop, sufficient safety clearances as required by the standard are ensured at the bottom and top of the well. When the lift gets into safety mode and if the car is in the safety clearances, its movement can only be towards leaving this clearance. However, it cannot pass these switches again when moving in safety mode. When the normal mode is activated, these switches are deactivated and normal mode switches are enabled. Moreover, FITLIFT keeps mechanical safety gear locked in both normal and safety operating mode at each stop of the car and prevent it against an undesired movement.

IN SAFETY OPERATION
THE POSITION OF THE RELAYS



This system is specially designed for FITLIFT. Changes were made in lift circuits for the functioning of the system, additional systems were applied to provide required safety supports for the circuits and approval was received by presenting it to the inspection of the Notified Body. Different systems can be developed and mechanical automatic systems can be created instead of electrical automatic systems but, the requirement that there should be a manually activatable system in case of a *mistake-proof-by-design* or automatic system that does not require an intervention requested by the standard should be met.

6. FITLIFT WELL DIMENSIONS

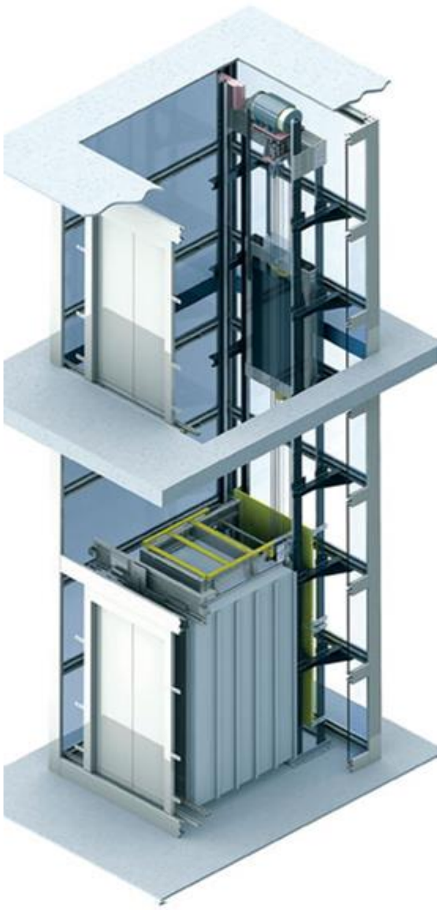
Taking the operating mode in two separate section and solving the clearances needed for safety mode within the normal operating range provide advantage to FITLIFT in terms of well bottom and top. By this way, it enables to install lift in cases of creating a 18 cm (7.08 inch) depth on the ground without any need for pit in the existing buildings or heightening the entrance with a 18 cm step. At the top floor, 260 cm (102.36 inch) range from the floor level is enough for top of the well. This dimension is calculated for automatic car door mechanism. If swing or folding door is preferred, the system can operate in shorter ranges. If it is considered that the normal floor height is at least 270 cm (106,29 inch), it has become easier to install lift to the existing buildings without making any change at the top floor.

FITLIFT HYDRA

For the need of usage in buildings and detached houses with short travel range, FITLIFT HYDRA system was developed. FITLIFT HYDRA is a hydraulic lift and can use same sling systems and by taking the hydraulic tank into the well the need for additional area is eliminated. A special emergency rescue system was developed for FITLIFT HYDRA and usage of it at home has become more suitable. When a person living alone is stuck in the car in any case, he/she can be evacuated from the lift by performing emergency rescue within the car. This provides convenience for especially the elderly people living alone.

We should make a distinction between FITLIFT and normal HOMELIFT elevators. We can list the outstanding differences between them as follows:

1. FITLIFT is a normal elevator installed in the wells with reduced dimensions. There is not a number of floor and well height restriction. It can be installed in the demanded numbers of floor.
2. FITLIFT can use 1 m/s as speed. Speed of the homelift elevators installed according to the Machinery Directive is restricted with 0.15 m/s. It provides a great advantage that the speed is higher compared with the platform lifts for the multistorey buildings.
3. FITLIFT features a normal lift control system. It is not required to press uninterruptedly to the button of the floor to be accessed. It will be enough to press once normally.
4. It can be used in multistorey buildings with intense traffic. It is suitable for mitigating the traffic intensity in buildings where the traffic flow is not enough.
5. Car and landing doors can be fully automatic, car pattern and allocation within the car can be chosen among many alternatives by the user.
6. It is a high-level safe lift having the normal lift safety devices against floor leveling, upward alignment and other unexpected car movements.
7. FITLIFT meets the safety requirements of “Lift Directive”. It is inspected by the Notified Body and certificated with CE document. It differs greatly from the platforms assembled according to the machine safety.



Therefore, FITLIFT has a different structure than other lifts or platforms produced for the wells with reduced dimensions. With these features, FITLIFT TRAC and FITLIFT HYDRA elevators provides convenience and high-level safety for the installation of new lifts to the existing buildings. They have been produced and used in the field for approximately 8 years. They also made easily usable and functional through the improvements performed at several points. Their transporting capacity is enhanced.

Strojírenský zkušební ústav, s.p.
Notified body, identification No. 1015

CERTIFICATE
EC TYPE EXAMINATION
Module B
No.: 1-61-13952/11/ZZ

YETERLİFT ASANSÖR SAN. VE TİC. LTD. ŞTİ.
- Istanbul - Turkey

Electric lift designed to carry persons

Type:
FITLIFT

FITLIFT 320, FITLIFT 450

See Annex No. 1-61-13952/11/ZZ/1

Directive of the European Parliament and Council 95/16/EC
by the Annex V (module B)

Ing. Jiří Rozsíval, MBA
Deputy Director

www.szutest.cz

CONCLUSION

EN 81-21 standard is used as a guidance for the lifts installed in the wells with reduced dimensions. When the problems grew at this point, EN 81-20 Standard made an explanation about this issue. It stated within the scope section that EN 81-21 standard should be used for these wells with reduced dimensions.

“EN 81-20 2014 1 Scope
1.3 *This standard does not cover:*
……..c) new passenger or goods passenger lifts in existing buildings 2) where in some circumstances due to limitations enforced by building constraints, some requirements of EN 81-20 cannot be met and EN 81-21 should be considered;”

The performed risk analysis should be reevaluated in this case and solutions that clear up the risk should be provided. It is not possible to eliminate the risk just by using a moveable buffer pedestal in these types of lifts. Because, these kinds of safety systems are generally not used by the service personnel when they enter into the well. Creating the requirements of switching to the forced safety mode demanded in the standard will provide safer conditions for both users and the maintenance personnel.

Respectfully yours,
Serdar Tavaslıoğlu Elc. Eng.