DOMESTIC LIFTS : A NEW ERA

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ABSTRACT:

In medium high rise residential properties, it is generally economic to install a conventional lift, for the use of the residents. In low rise properties (up to 3 stories) lifts are not installed except in luxury accommodation.
However, it is important that residents, the old and infirm, can travel comfortably, to and from their homes, and the outside world. Thus a safe and inexpensive lifting unit needs to be provided, which should be considered as a necessity. A lift complying with the Machinery Directive will be described. Its basic features are rated load: 150 / 250 kg,
rated speed: 0,1 m/s; maximum travel: 10 m, power consumption 0,75 / 1.1 kW.

1) INTRODUCTION

The main reason why we make this new product is that we feel that the society needs it.
The two main ideas why we make this product are: firstly because, people on average, are living longer than before, and their needs are more and more important, secondly, there is an increase in the attention around disabled people and the solving of their problems. This lift is thus compact, nearly a household appliance, can be fitted in all dwellings, has the cost of a city car, but has all the safeties of a lift. The domestic lift is a lifting platform for disabled persons, intended for both private and public use.
It falls within the category of products indicated in Attachment IV, section A16 of the Decree of the President of the Italian Republic 24/07/96, No. 459 "Passenger lifting apparatuses with a risk of vertical fall exceeding 3 metres" (in the following referred to as DPR 459/96). DPR 459/96 implemented in Italy the European Machine Directive 89/392/CEE.
The design of the platform is made in the absence of a harmonised reference standard. In Italy, the design and the successive putting into service of the platform are carried out in compliance with DPR 459/96, according to which the platform is certified.
The apparatus complies with the Italian Law Decree (DL) 476/92, which implemented the European Directive 89/336/CEE on electromagnetic compatibility (EMC).
To better understand the impact of the domestic lift in the society, I would like to divide my presentation in four different aspects: social, architectural design, economic, technical.

2) SOCIAL

Probably you may think that a lift is not concerned with social problems. What do you imagine when I am talking about a modern city? Technologically advanced? Probably, you would think about New York, Hong Kong, Tokyo and so on. In any case, everybody would think about a town with skyscrapers. Nowadays, the skyscraper is still the symbol of modernity and civilisation.
For many years, engineers and architects working in the construction fields, have tried

to built taller and taller buildings; none of this would have been possible without the elevator that 100 years ago had been of great importance for the building industry.
With all the useful things that we are using everyday, we take them for granted.
A power cut will interrupt all the activities of a town. The failure of a lift will stop the " life " of a building. As it is clear, an elevator is important in a skyscraper (who is going to walk to the 28 floor without it?) but it is not so easy to see the necessity of a lift in a small three floor building or in a family house of two floors only. Now things are changing. The lift is now indispensable. Many of us in fact, do not live in skyscraper, but in a building of few floors only. The expectation of quality of life is getting higher and higher (just think about fax, mobile phone, Internet and so on). And for us, climbing up one floor starts to be a nuisance. Up to now we considered healthy people, who are just too lazy to walk, nothing else. Now we start thinking about handicapped people, the elderly, people with heart problems, and all those who cannot work. To all of them stairs and steps are serious obstacles. Now it is clear why we must take into consideration the social aspect in respect of the domestic lift. Up to ten years ago, there was not this kind of mentality. Nobody cared if handicapped people, for example, could not go to the cinema. Slowly, some politicians and others began to think seriously about it. First there was a big effort of the Scandinavian countries; then, Parliaments of other countries handled this matter very carefully. For example the USA with the Americans with the disabilities act (A.D.A.).
The sensibility around this matter is slowly increasing and is having large effects; also handicapped and elderly people have rights and expect more freedom.
So, thanks to the new norms, it is now possible to manufacture a domestic lift, which is compact, easy to install, cheap and with all necessary safety devices. Up to now, thanks to the lift, there has been a big technological developments of the towns. Having elderly people or somebody ill at home will be not a problem any more. From now, the domestic lift will make the town more socially developed. The elderly people can live their lives normally without any problems.
Now I would like to tell you what happened to me a few months ago.
During a dinner with friends, someone whom I did not know told us that their neighbours living in a two floor house, had an accident. The father broke both his legs and could not move without a wheelchair. As a consequence, the family was nearly forced to sell their house, where they had lived for many years. I asked the address of these people, and after contacting them, they got a domestic lift. They have not solved their problem, but at least, with the lift, we avoided them having to change the house. This, of course, was just an episode, luckily not all the cases are so desperate. In many cases the domestic lift represents something to make life easier or more comfortable. The way of living at home is changing.

3) ARCHITECTURAL DESIGN

Now let's talk about the architectural design of the domestic lift.
I am going to start with a famous sentence of the architect Le Corbusier:
" stairs separate, ramps gather ", now with domestic lift you can change this say as into
" stairs separate, domestic lift gathers". As mentioned before, I am sure that the domestic lift will change the way houses are designed, it will increase the opportunity of dividing space, and will make it much easier to build houses of two floors which are pleasant and easy to use.
Two famous Italian architects Salvati and Tresoldi, interviewed about domestic lift
Said: " The lifts for years have been on one side a status symbol, a public object, which has nothing to do with the internal furniture of a house; Now, when it will be understood that domestic lift can become a piece of furniture, then a new world will open up. Aesthetics will play a fundamental role: some people will cover it with mirrors, some other with fabrics or wood, some may want a glass lift. Everyone will give a personal touch. "

4) ECONOMIC

From the economic point of view, the domestic lift present two different advantages, one immediate, and the second one during its daily use.

4.1 Purchase cost

Cost is one of the most important factors of a domestic lift; it has to be much lower than the cost of a conventional hydraulic lift. As the cost is significant many manufacturers can make arrangement with financial institutions to provide loans for the purchase of a domestic lift. In this way, people are helped that don't have available at one time the whole Purchase price.

4.2 Energy consumption

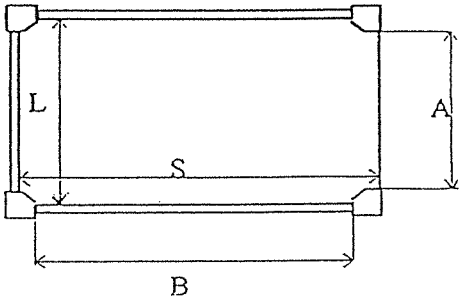
The domestic lift must work from the standard home electrical socket operating at 220 V / 240 V single phase.

The current consumption should be low. If we imagine an average of 120 trips per day, then the consumption cost per month must be small!

5) TECHNICAL DESCRIPTION

5.1 GENERAL CHARACTERISTICS

The model configuration of an apparatus with a car having general size A x B is shown in the figure.



Distance between the car uprights		Internal dimensions		
A mm	B mm	L mm	S mm	Rated load kg
750	750	800	840	150
750	950	800	1040	150
750	1250	1000	1340	250
950	1250	1000	1340	250
950	950	1000	1040	250

The lifting platform is comprised of:

- a car including a floor, side walls and a roof bearing no load. The car entrance is not fitted with a door, but it is protected by photocells. The car is provided with internal lighting;
- a sling, which supports the car and allows its vertical sliding on suitable guide rails;
- a side acting drive controlled by a hydraulic power unit. The car is suspended through metal ropes. The roping factor is 2:1 and the jack operates under pull;
- an electrical controller, accommodated together with the hydraulic power unit in two separate compartments of a single control cabinet;
- landing doors, of the manual swing type, with call pushbutton panels; a motor drive for the landing doors is available on request;
- a continuos pressure pushbutton operating panel, fitted in the car, to control the upward and downward travels, the stopping of the car, the alarm signal and the descent to the lowest floor in case of mains failure;

- an inclined plane is available on request, to facilitate the access to the car from the lowest floor.

A shaft, having blind walls over its entire surface, encloses the car and the movable components. In addition to the landing doors, the shaft may be provided with ventilation apertures, placed in a position not accessible from the car and protected against the introduction of foreign bodies from the outside.

5.2 USE LIMITATIONS

The performance and use of the platform are defined as follows:

- upward and downward speeds: ranging from 0.10 m/s to 0.15 m/s;
- maximum travel: 10 m;
- maximum number of stops: 4, with the possibility of two landing doors at floors;
- internal rated dimensions of the car: ranging from 650 x 650 mm to 1000 x 1300 mm. Internal clear height of the car: 2024 mm. Maximum car dimension in the overhang direction: 1000 mm max.;
- one or two car entrances;
- clear openings of the car entrance and the landing doors: ranging from 600 mm to 1250 mm. Clear height: 2000 mm;
- rated load: either 150 kg or 250 kg, according to a ratio of 180 kg/m^2 of the available car area;
- capacity: one standing up person for each 75 kg of rated load or one person sitting on a wheelchair instead of two standing up persons for car dimensions of at least 800 x 1300 mm;
- contract power: ranging from 0.75 kW to 1.1 kW.

In particular, the model configurations include:

- car with rated dimensions of 800, 1000, 1300 mm, to yield the combinations 800 x 800 mm, 800 x 1000 mm, 800 x 1300 mm, 1000 x 1000 mm, 1000 x 1300 mm;
- rated load of 150 kg for rated car areas up to 0.8 m^2 (car size 800 x 1000 mm) and 250 kg for larger car areas. The platform with rated loads of 150 kg and 250 kg are structurally the same. They differ only in respect of the power sections of the electrical controller and the hydraulic power unit;
- clear door opening of 750 x 2000 mm and 950 x 2000 mm.

The maximum reference weights are Q = 2320 N for the car plus the car sling and 2500 N (≅250 kg) for the rated load.

5.3 NOISE

The platform average noise level is about 45 dbA, both in the car and in proximity of the control cabinet (with closed door).

5.4 SHAFT

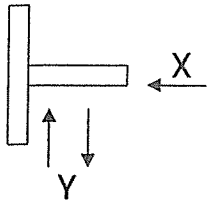
5.4.1 Characteristics

The shaft surrounds and encloses completely the space wherein the platform travels. It can be implemented by means of masonry, reinforced concrete or metal structures and plugged up with fireproofing materials, which are rigid durable materials and do not favour the deposition of dust. The owner of the platform is responsible of ensuring the compliance of the shaft with the building or anti-fire regulations and with the requirements set forth herein.

The interior of the shaft must be weatherproof, protected against damp and water condensation and its temperature must always range from 5°C to 40°C.

The wall facing the car entrance must be blind, smooth and continuous, with protruding and recessed parts not exceeding the depth of 5 mm and always radiused, except the clearances

required of the door operation. The wall must not undergo an elastic deflection exceeding 10 mm or any permanent deformation, when a force of 300 N is applied perpendicularly to a circular surface of 500 mm² in any point of both the sides of the wall.
The shaft as a whole must be capable of resisting the forces induced by the operation of the platform. These dynamic forces are converted into static forces by multiplying them by a dynamic factor of 1.5. The static values to be used for the sizing of the shaft are summarised in the following table. They correspond to the forces exerted by the guide shoes on the guide rails and to the load on the pit in the zone of the pit bed beam. In addition to the above, the pit floor must be able to withstand an evenly distributed static load of 5000 N/m², provided it is not applied simultaneously with the other loads considered above.



FORCES IN THE SHAFT		RATED LOAD	
		150 kg	250 kg
vertical load in the pit, on the pit bed beam		10000 N	12500 N
horizontal force on the guide rails	X	1000 N	1200 N
	Y	700 N	1100 N
static load of 5000 N/m², evenly distributed on the pit floor			

5.4.2 Illumination
The shaft is provided with its own light circuit, including a current tap and a switch.

5.4.3 Shaft head
The dimensions of the components and the installation requirements call for a shaft head of at least 2700 mm. Since the methods for carrying out the maintenance do not require to stand above the car (which has a roof bearing no load, anyhow) this head height automatically provides the upper safety space for the maintenance technician.

5.4.4 Pit
The dimensions of the components and the installation requirements call for a pit height of at least 100 mm. Since the methods for carrying out the maintenance require getting into the pit with the car at a higher position, the safety space for the maintenance technician is obtained by means of a movable safety bar. This safety bar can be applied to either the right or the left guide rail, according to the type of access through the lowest landing door. A hinged bracket maintains the bar in a vertical position and allows its rotation from a rest position to a working position. Both positions are made stable by means of a locator on the pit bed beam.
The car can travel downwards only until its abutment against the safety bar turned to the working position. A safety space is so obtained in the pit, having a height of at least 1000 mm. The width and the length of the safety space depend on the size of the platform, with a minimum of 750 x 750 mm in the case of the smallest car.

5.5 GUIDE RAILS
The guide rails are vertically arranged in pairs at a rated distance of 680 mm. They are fixed to the rear shaft wall by means of brackets and support the car sling on the front side.
The guide rails and their fittings correspond to type T70-2/A according to UNI ISO 7465 (size 70 x 70 x 8). They are made of drawn Fe360 steel, cut to a length of 2.5 m or multiples thereof and have the end sections cut to size according to the shaft height. Each guide rail section is fixed to the adjacent section through a male/female junction, a fishplate and bolts.
The guide rails are used also for the positioning of the devices for the control of the platform operation (brackets, magnets, contacts, ...), the shaft light circuit and the fitting of the safety bar ensuring the clear space in the pit.

5.6 CAR SLING

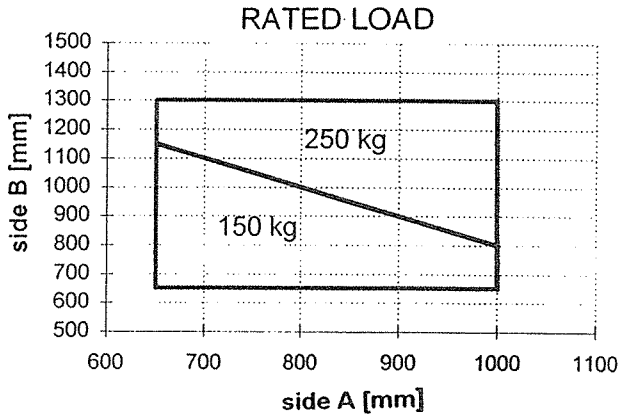
The car sling is the same for all the car sizes and is made of bent steel sheet sections (thickness: 3 mm and 4 mm).
It is comprised of two vertical uprights, which are joined together by an upper horizontal cross beam and a lower horizontal cross beam, positioned at about half height, carrying the safety gear. Two bolts are used at each junction.

5.7 SAFETY GEAR

The function of the safety gear is to stop the car and to maintain it clamped in the case of slackening or fracture of a suspension rope. The safety gear is fixed to the lower cross beam of the car sling by means of bolts and is formed by a body having two converging faces and a movable roller fitted therebetween. A safety gear rope having a diameter of 13 mm is threaded between the roller and one of the two faces. The safety gear rope is taut between the top portion of the guide rails and the pit bed beam. During the travel of the platform, the safety gear and its roller run without contacting the safety gear rope , which is stationary.If a suspension rope slackens, a return spring pushes a lever, which raises the roller and brings it into contact with the inclined face and the safety gear rope. The friction between the parts in relative movement (car travelling downwards) causes the roller to wedge itself in to clamp the safety gear body, and hence the car, onto the safety gear rope.
During its movement, the lever trips also an electrical safety contact, which disables the electrical operation of the platform.

5.8 CAR

The rated internal dimensions range from 650 x 650 mm to 1000 x 1300 mm, with a clear height of 2020 mm. The plan external dimensions are equal to the internal dimensions plus 80 mm, whilst the external height is about 2130 mm. The rated load is either 150 kg or 250 kg, according to a ratio of 180 kg/m^2. These values are summarised in the following diagram.
However, it is possible to assign a rated load of 250 kg to all the cars by simply adapting the power sections of the electrical controller and the hydraulic power unit, since all the other components are structurally the same.



5.9 CAR OPERATING PANEL

The car operating panel is fitted to a car wall, under the lighting fixture.
It includes:

- constant pressure pushbuttons for driving the car to the selected floor. Each pushbutton bears a symbol identifying the associated floor;
- an alarm pushbutton to operate the alarm siren. This pushbutton bears the symbol of a bell and is encircled by a yellow border;

- a bistable STOP switch for disabling any movement of the platform. The switch is coloured in red and is accompanied by the legend STOP affixed close to it;
- a key switch for enabling the electrical operation of the pushbuttons controlling the travel of the platform to the floors (the STOP switch and the alarm pushbutton are always enabled). The key switch can be omitted when there are other ways to control and limit the access to and the use of the platform (e.g. a private house).

5.10 THE DRIVE SYSTEM

As already said, the platform drive consists of a side acting jack controlled by a hydraulic power unit. The stroke of the jack causes the movement of the platform through diverted ropes.There are two steel suspension ropes having a tensile strength of 1570 N/mm², a diameter of 9 mm and lay of rope of 8*(1+9+9) = 152 wires. These characteristics are according to ISO 4344 Standard. The ropes are fixed by means of three grips secured to the folded and overlapped ends of the ropes.
The jack is fixed to the pit bed beam and to the guide rails, under the cylinder head, by means of a collar. The ram carries a diverting pulley and the ropes develop their path from a fixed point of the upper cross beam of the guide rails, downwards around the diverting pulley on the ram, upwards to a fixed pulley on the upper cross beam of the guide rails and downwards again to the safety gear cross beam of the car sling.
In this way a 2:1 roping system is implemented, with the ram operating under pull and moving in a direction opposite to the direction of the car movement. The stroke of the ram is about half the travel of the platform. As far as the car load is concerned, the ram length is not relevant since the ram works under pull.

5.11 RUPTURE VALVE

The jack is provided with a rupture valve placed at the top of the cylinder. This valve cuts off the upstream oil delivery when there is no counterpressure downstream. The valve is adjusted to trip when a pressure differential is detected corresponding to a downward speed of the platform of about 0.2 m/s. The oil flow in the opposite direction (i.e. from downstream to upstream) is free.

5.12 HYDRAULIC POWER UNIT

The hydraulic power unit is placed in the lower compartment of the control cabinet. A door provided with a triangular key closes the compartment.
The motor and the pump are installed on the reservoir. The pump is submersed in the oil and is provided with a filter on the suction side. The flow rate is 6 l/min, which yields a rated upward car speed of 0.12 m/s. The motor is air cooled, with the following characteristics: 4 poles, 230 V single-phase, 50 Hz and 0.75 or 1.1 kW (1.0 or 1.5 HP) for rated loads of 150 or 250 kg, respectively.
The oil is of the ISO VG22 (or higher grade) type, intended for the specific use in hydraulic circuits and with anti-wear, antioxidising, antifoaming and anti-corrosion additives.

5.13 ELECTRICAL CONTROLLER

The electrical controller is placed in the upper compartment of the control cabinet. A door provided with a triangular key closes the compartment.
Different electrical diagrams are provided according to the number of stops, whilst the related components vary according to the motor rating.
The main switch placed on the platform control cabinet is connected to the mains by means of a 220 V, 16 A, single-phase plus ground line.

The output voltages from the electrical controller are 220 Vac for the hydraulic power unit, 24 Vdc for the control devices and the car.
The connections between the controller, the shaft and the car are made through pre-wired lines. The controller includes a buffer battery, which provides the emergency power supply for the platform operation in case of mains failure. This power supply automatically turns on the car light (controlled on the basis of the "in use time") and the illumination of the pushbutton associated with the lowest floor. It allows also the operation of the alarm pushbutton and the travel of the car to the lowest floor by means of the constant pressure pushbutton, with the resultant automatic stopping of the car, the unlocking of the door and the possibility of leaving the car. This emergency operation can be carried out also from the landing pushbutton panel of the lowest floor.
In addition to the normal operation control means, the controller is provided with means for carrying out the maintenance operation. The use of the maintenance operation is restricted to the maintenance technician and can be enabled by turning a special bistable switch in the controller. When the maintenance operation is enabled, the platform responds only to the commands from the car, whilst the landing pushbutton control panels and the anti-creep operation are disabled.

5.14 LANDING DOORS

The access to the car from the landings takes place through the landing doors, placed in correspondence of each level served.
The clear width of the car ranges from 600 mm to 1250 mm, according to the corresponding car dimensions. The clear height is always 2000 mm.
The door includes a frame made of aluminium sections. The frame is fixed to the shaft and supports a hinged swing door. The door lock is located on the opposite side. The lock is of type certified for lifts under EN 81.The door is locked through a bolt whose engagement is controlled by a positive break contact. The lock includes a second positive break contact, which detects the approaching of the door.

5.15 LANDING PUSHBUTTON PANEL

The landing pushbutton panel is placed on the door frame or close to it. The panel includes a constant pressure pushbutton for calling the car and two signal lights, a red "in use" light (embodied in the pushbutton) and a green light indicating that the car is "here". In addition, a key switch is fitted into the control panel for electrically enabling the pushbutton. The key switch can be omitted when there are other ways to control and limit the access to and the use of the platform (e.g. a private house).

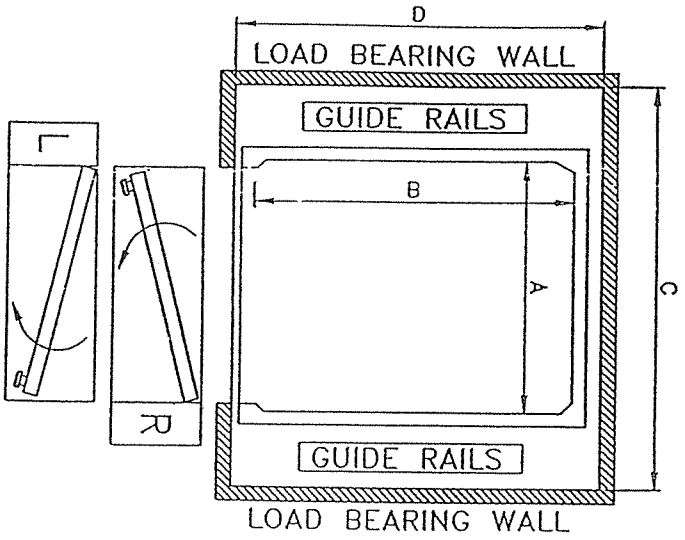
5.16 SAFETY DEVICES

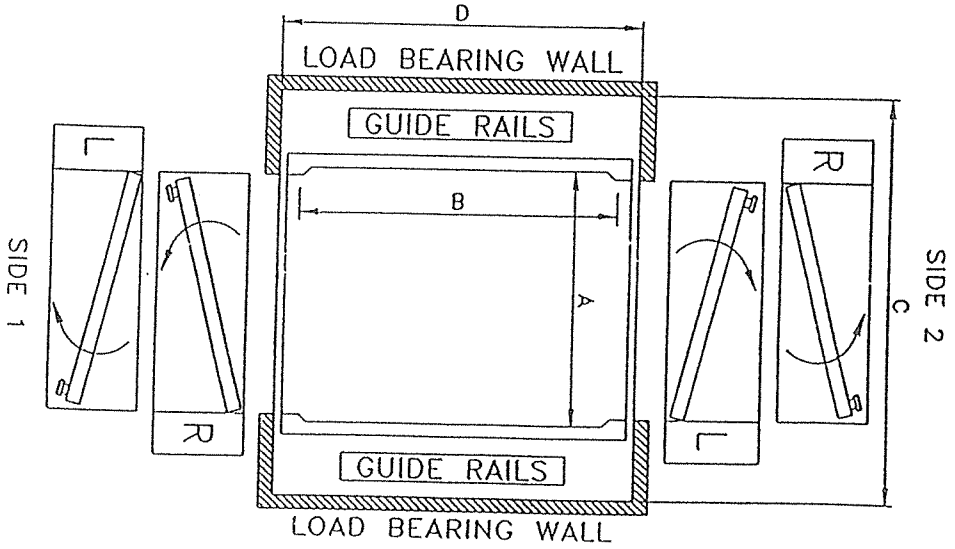
The safety devices listed below were also described in the preceding related sections.
- Constant pressure pushbutton operation
- Overload pressure switch
- Pressure relief valve
- Hand pump provided with its own pressure relief valve
- Pushbutton for the manual emergency descent
- Emergency power supply for car lighting and controlled descent operation
- Safety gear with an electrical contact, tripped by the slackening of the ropes
- Upper overtravel switch of the positive break type
- Photocells at the car access
- Safety bar in the pit
-Rupture valve on the cylinder

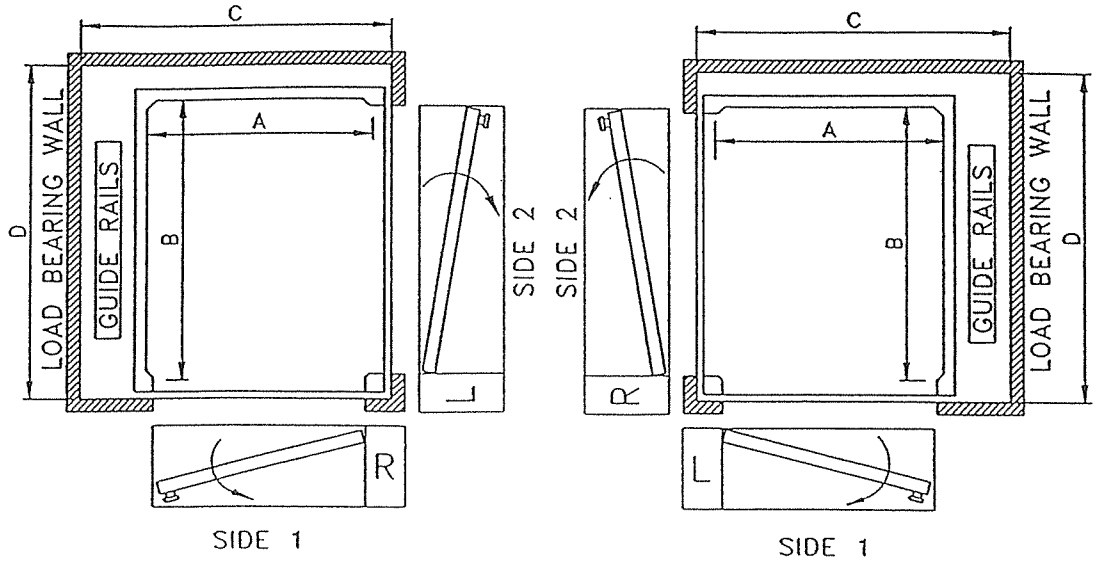
- Door locks certified according to EN 81
- STOP switch
- Alarm pushbutton
- Enabling key fitted into each pushbutton panel
- Shaft lighting
- Maintenance operation
- Safety guard on the pulleys
- Electrical earthing
- Set of plates
  1 - plate in the pit, indicating danger and requiring the setting of the safety bar;
  2 - plate on the car roof, indicating that the roof cannot bear any load and prohibiting access thereon;
  3 – plate on the control cabinet indicating danger and prohibiting access thereto;
  3 – plate close to the electrical controller, indicating how to act on the controller;
  5 – plate close to the red pushbutton P for the emergency descent, identifying it;
  6 – plate on each landing door, indicating that the use of the platform is restricted to disabled people;
  7 – plate in the car, indicating the rated load, the capacity and the name of the manufacturer.

6) CONFIGURATION EXAMPLES

Here you can see three examples of possible configurations :







7) CONCLUSIONS

We described the main aspects of this domestic lift. It is important to notice that nowadays, a product, to be successful, should satisfy different aspects of its functionality.
To manufacture and design the domestic lift, we have considered people needs and people problems and taken advantage of our technical knowledge and know how to produce it accordingly.
This concept will be the starting point to design and manufacture new products, for which people expectation is higher and higher.

8) REFERENCES

DPR 459/96, which implemented the European Machine Directive 89/392/CEE in Italy.
Italian Law Decree (DL) 476/92, which implemented the European Directive 89/336/CEE on electromagnetic compatibility (EMC) in Italy.

9) BIOGRAPHICAL DETAILS

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After having attended the I.T.S. (Switzerland) and having got the engineer degree in 1990, he starts working with I.G.V., for one year in the technical office of the new lift design department and thereafter in the export sales office.
In 1993 he went to manage the IGV affiliate company in Sweden and from 1994 he is area export manager for Eastern Europe, Far East, U.K. and Scandinavian countries.