Lift Technology Development

Multi-Car Systems

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Lift Technology Development Multi-Car Systems

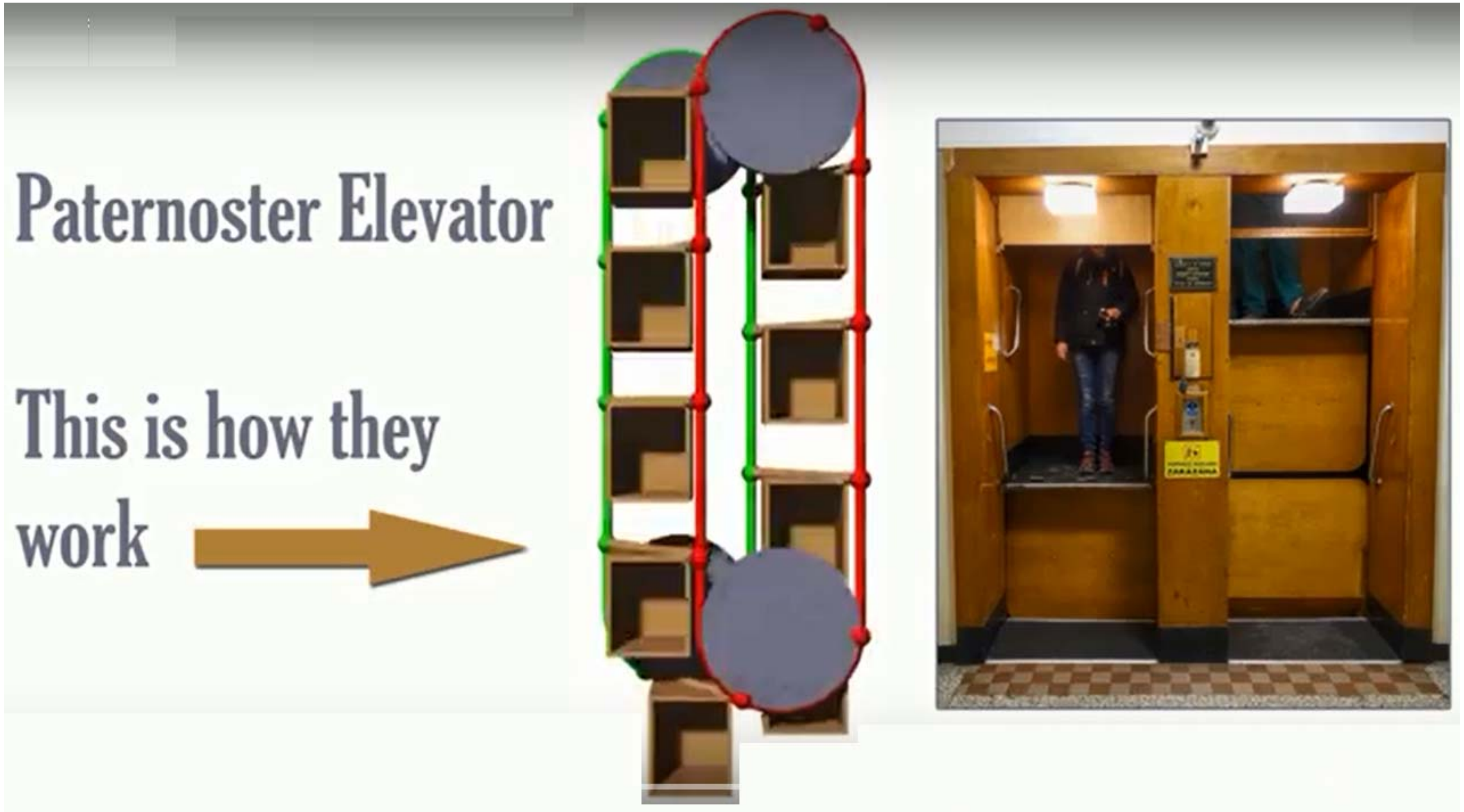
- Multi-Car Systems
- TWIN Concept and Benefits
  - Pulley System
  - General Arrangement
  - Safety Provisions
  - Provisions for Builder & Other Contractors
  - Liftshaft Splitting into 2 Dynamic Zones
  - Positive Monitoring Slowdown of Lift towards Bottom Landing
  - Operation & Maintenance
- Multi
- Space Lift
- Q&A

Multi-Car Systems

No. of Car in Liftshaft (井道內機廂數量)

- 1 car in 1 shaft (1個井道1台機)
- Many cars in 2 shafts (2個井道多台機)
- 2 cars in 1 shaft (1個井道2台機)
- Many cars in 1 shaft (1個井道多台機)
- Many cars in many shafts (多個井道多台機)

Multi-Car Systems



TWIN – Introduction

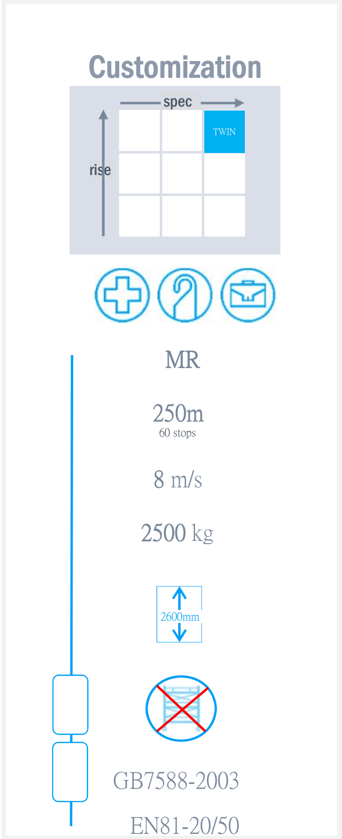
- New specialist medical centre of Hong Kong Sanatorium & Hospital (HKSH) to be constructed in the eastern part of Hong Kong Island.
- 3 TWIN systems
  - Speed: upper car 3.0 m/s, lower car 2.5m/s; Load: 1800 kg
  - Passenger / bed lifts
- 1 TWIN system & 1 conventional lift
  - Speed: upper car 3.0 m/s, lower car 2.5m/s; Load: 1800 kg
  - Service lifts
- Expected completion: 2019

TWIN

TWIN – Introduction

Introducing TWIN

- The most unique and innovative technology in the world:
  - two cars moving independently in the same shaft
- Less no. of shafts result in maximize lettable floor space and minimize waiting time



TWIN - 2 Cabs. 1 Shaft. 0 Crowds.

TWIN – Target Segment

Target Building

TWIN is designed for premium high-rise building including new installation and modernization

- Hotels
- Offices
- Hospitals

Target application

Maximum configuration of TWIN

- Rise: 250m
- Load: 2500kg
- Speed: 8m/s

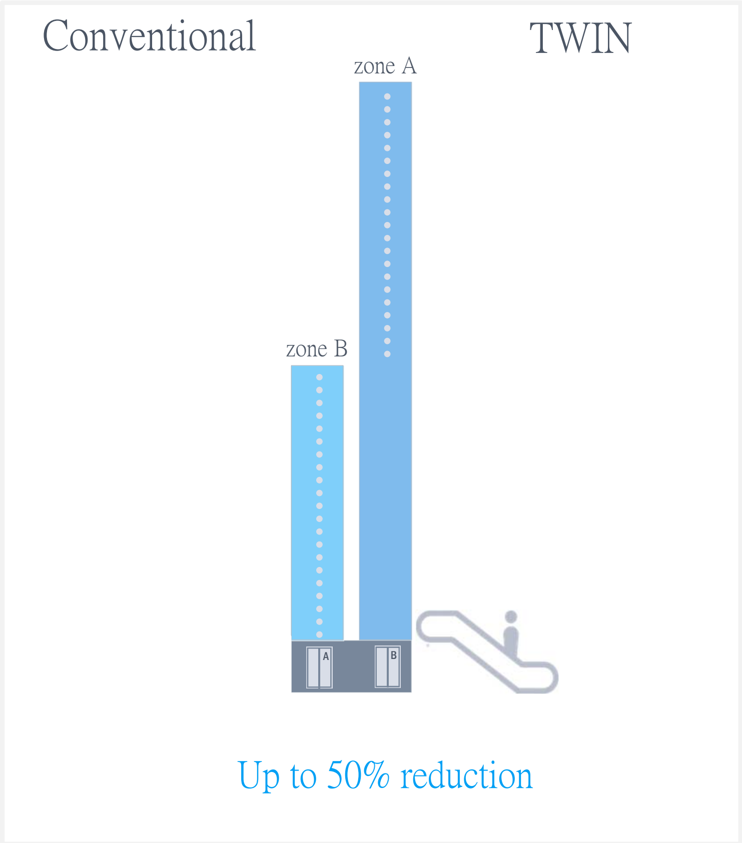



TWIN is space efficient for new installation and increases traffic handling capacity in existing buildings

TWIN – Advantages

Maximize lettable area	2 cabs in 1 shaft	1. 2 independent cars in 1 shaft reduce the core size of a building up to 50% thus reducing construction cost in both labor and materials. 2. Reducing the core size increases the lettable floor space of a building, thus increasing the rental income for the developer.
Minimize time to destination	0 crowds	1. 2 independent cars in one shaft reduces the "Average Travel Time to Destination" (ATTD) up to 50% as proven by the "Elevate" elevator traffic analysis & simulation software. 2. The "Destination Control System" (DSC) acts as a concierge to direct passengers to elevator, and group passengers with same destination, thus further increasing the traffic efficiency in the building. 3. For existing buildings, TWIN is the ideal solution to drastically reduce the ATTD in congested buildings using the existing shafts.
Gives peace of mind	Trusted brand	1. 4 levels of safety prevent 2 cabins in the same hoistway from getting too close to each other

TWIN – Maximize Floor Space



TWIN maximizes the lettable floor space:

- **2 independent cars in 1 shaft result in a reduction the core size of a building up to 50% thus reducing construction cost in both labours and materials.**
- **Reducing the core size will increase the lettable floor space of a building, thus increasing the rental income for the developer.**

https://www.youtube.com/watch?v=V7N6z7FvF3I (TWIN – Development History_1.55)

TWIN maximizes lettable floor space

TWIN – Minimize Time to Destination

TWIN minimizes time to destination:

- TWIN runs with 2 cars in 1 shaft
  - 2 independent cars in 1 shaft reduces the "Average Travel Time to Destination" (ATTD) up to 50% which has proven by the "Elevate", the elevator traffic analysis & simulation software.
- TWIN comes standard with DSC (Destination Selection Control)
  - DSC acts as a concierge to direct passengers to elevator and group passengers with same destination. Elevator makes fewer stops and passengers arrive sooner to their destination.
  - Interruptions from passengers enter/exit at intermediate stops will be kept to a minimum.
- TWIN control system comes standard with Artificial Intelligence
  - DSC system integrates with advanced microprocessor technology and decentralized data
  - Intelligent call assignment of DSC system has self-learning ability that improve traffic performance based on traffic pattern

TWIN is the ideal solution to drastically reduce the ATTD in congested buildings by replacing the cabs and complying with the existing shafts.

TWIN – Actual Example

Application	Height	Floors	People
Office	220 m	47	5208

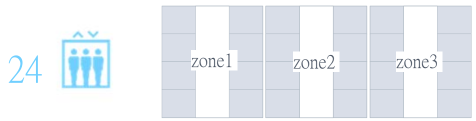
✔ Shaft reduction: 43%
✔ ATTD reduction: 45%

Before

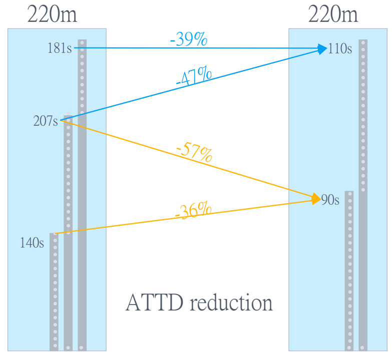
= 5208

Zone	Demand	AWT (s)	ATTD (s)
1	12%	46.4	140.4
2	12%	94	206.6
3	12%	63.2	181.2

average waiting time
average time to destination



Zone	Elevators	Load	Speed
1	8 SD	1600	3
2	8 SD	1600	4
3	8 SD	1600	6



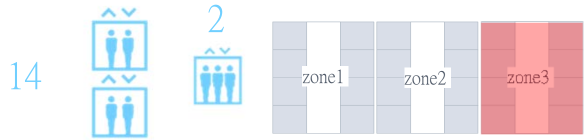
Actual space saved:

$4728\ m^2$

After

= 5567

Zone	Demand	AWT (s)	ATTD (s)
1	12%	31.9	89.5
2	12%	35.3	109.6



Zone	Elevators	Load	Speed
1	7 TWIN	1600/1600	4/2.5
1	1SD	1600	4
2	7 TWIN	1600/1600	6/4
2	1SD	1600	6

TWIN maximizes lettable floor space

TWIN – Peace of Mind

4-stages safety concept

- **Safety Level 1: Intelligent allocation of calls**
  Destination calls are assigned so that the minimum clearance between cars is maintained at all times.
- **Safety Level 2: Forced slow-down**
  Each elevator controller receives signals for actual position, direction of travel and speed of both cars. The remaining clearance is calculated using this data. If minimum clearance is compromised, the speed for both cars will be reduced, and they will stop at next possible landing. The minimum clearance is calculated with respect to the relative speed of each cabs, which means that the minimum clearance will increases with higher speeds.

TWIN safety measures make 2 cars moving independently become possible and safe

TWIN – Peace of Mind

4-stage safety concept

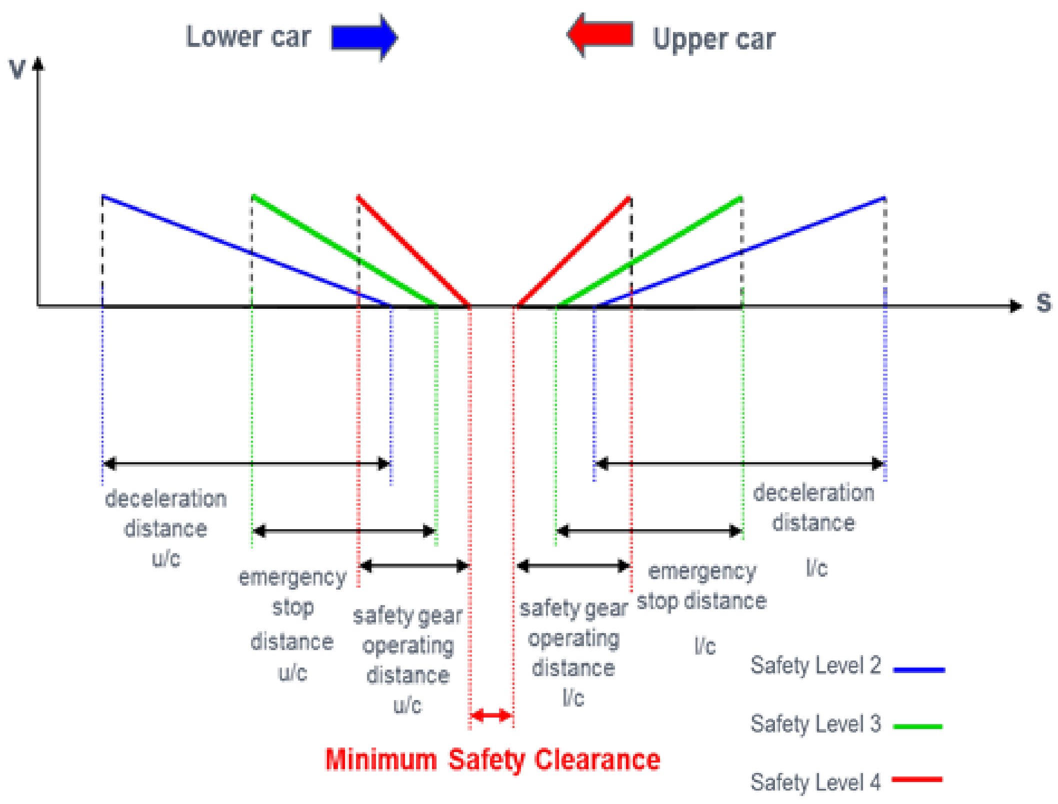
- Safety Level 3: Emergency stop function

At this level, electrical safety circuit is interrupted and the traction machines are stopped by activating the operating brakes.

- Safety Level 4: Automatic engagement of the safety gear

If the cab velocity has not come to rest, the safety gears are engaged at both cars.

Level 3 + 4 safety levels are monitored by an independent control system complying the highest safety classification of Safety Integrity Level3 (SIL3). According to the European Functional Safety Standard – the same safety level is deployed in components in: fly by wire (Airbus, Boeing 777); automatic train systems and the chemical industry.



TWIN safety measures make 2 cars moving independently become possible and safe

TWIN - Technical Specification

System Parameters

Machine Room

Machine A - 6.0 / 4.0 m/s

Machine B - 4.0 / 2.5 m/s

Side counter weights

Rated load 1250 / 1350 / 1600 / 1800 kg

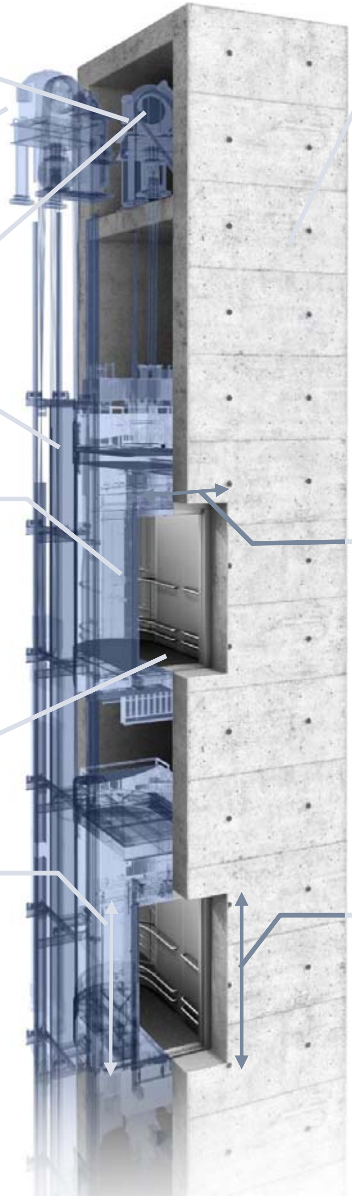
Higher rated load upon request

Center opening door
Left/right side opening door

Car Height 2600mm

2200 to 3000mm

EN81-20/50
GB7588-2003



Max. travel height 100/150 m

Speed (m/s)	Travel height (m)
4.0/2.5	100
6.0/4.0	150

Higher speed or travel height upon request

Door width 1100mm

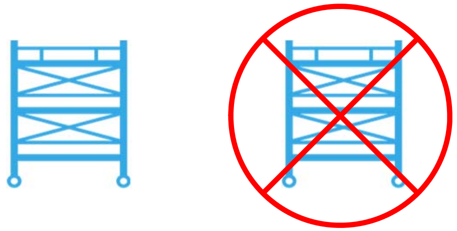
Door height 2400mm

2000 to 2700mm

TWIN - Installation Method

Methodology

- Scaffolding method (steel or bamboo)
- Scaffold-less method (tirak or guided-SWP)



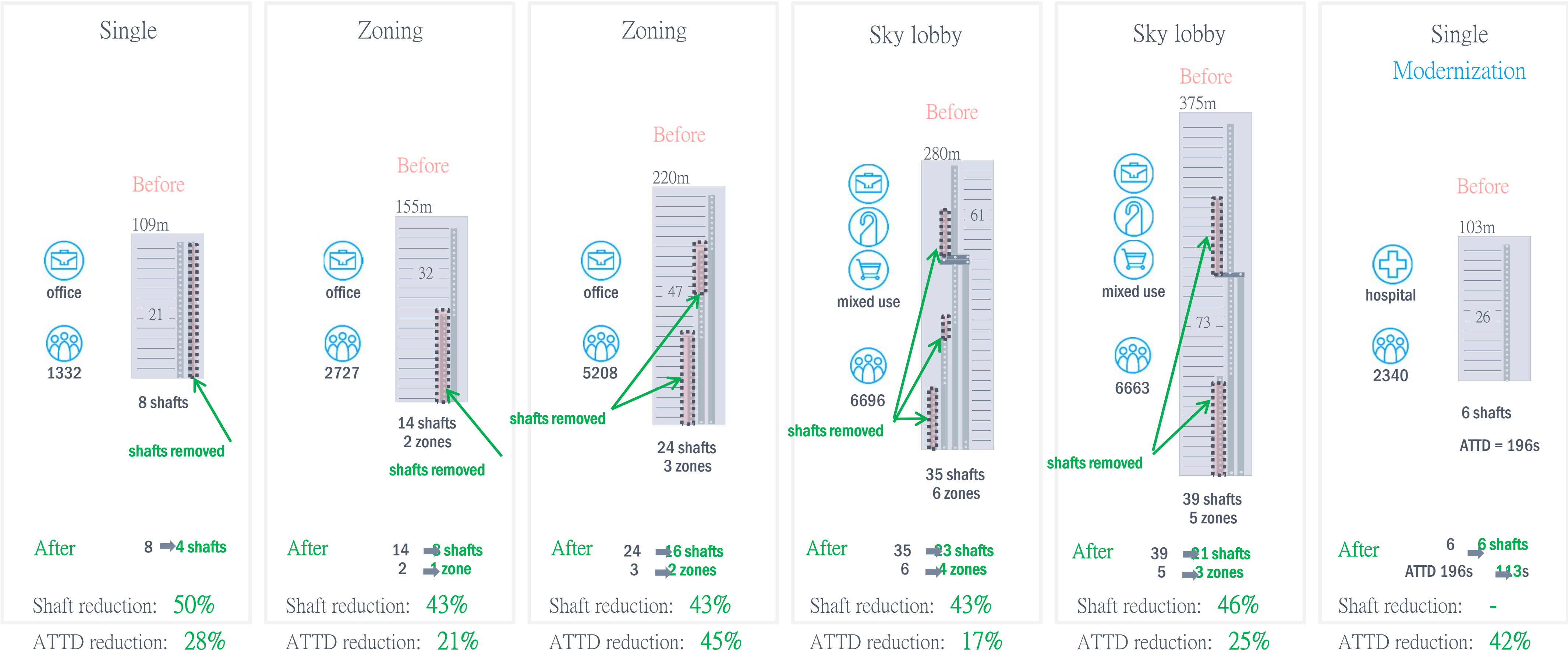
Installation Time

- Installation standard time for TWIN
- Less time is required for installation compare to conventional lift

hours

TWIN can use scaffold-less method

Comparing Traffic Solutions with TWIN – Actual Examples



Original set-up as proposed by Architect/Consultant

When to use TWIN Solutions or Conventional Solutions

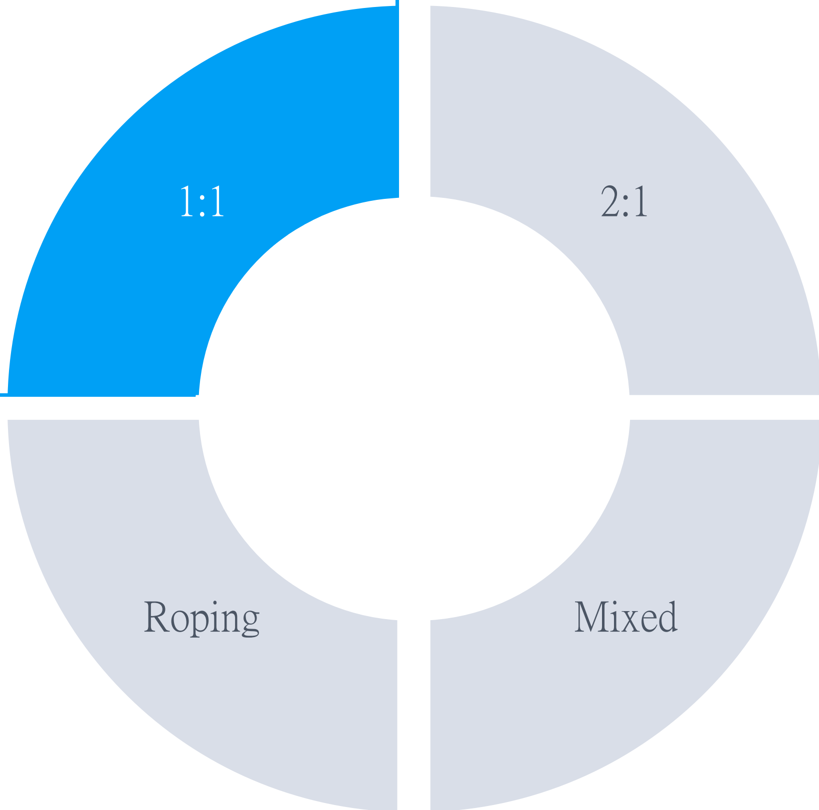
Traffic solution

Conventional ? TWIN

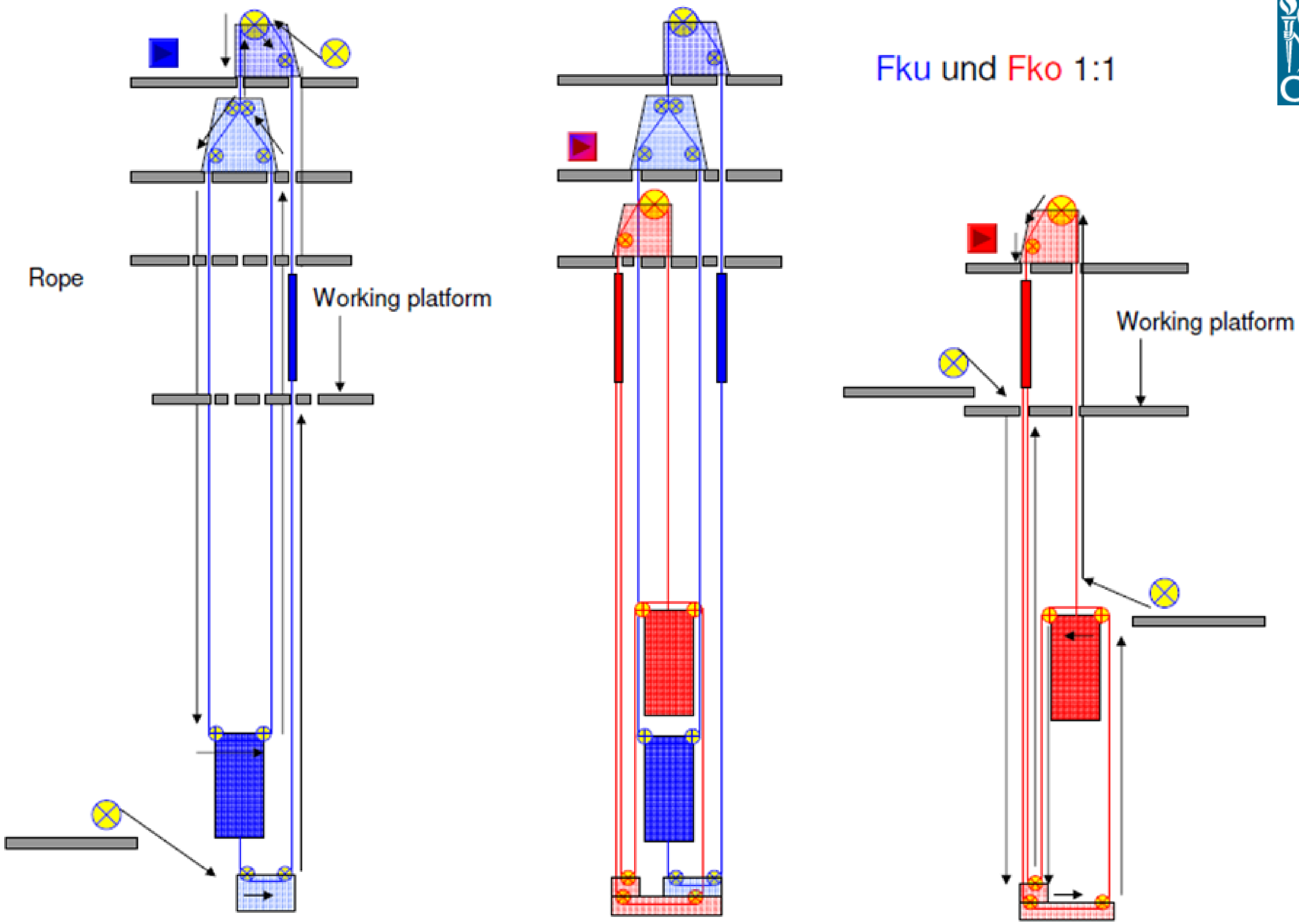
Conventional Choose when *one* of the following apply	*Parameter*	TWIN Choose when *all* of the following apply
Residential buildings	Building type	Commercial buildings
Low- to mid-rise	Rise	Mid- to high-rise
Lobby to destination only	Traffic pattern	Inter-floor traffic
Single level lobby	Lobby set-up	Two-level lobby
Low	Floor price / m^2	Medium to high
Simple traffic patterns	Traffic pattern	Complex traffic patterns
Low to medium number of people per floor	People/floor	Many people per floor (large floor footprint)

TWIN – Pulley System Arrangement

- 1:1 Upper Car
- 1:1 Lower Car

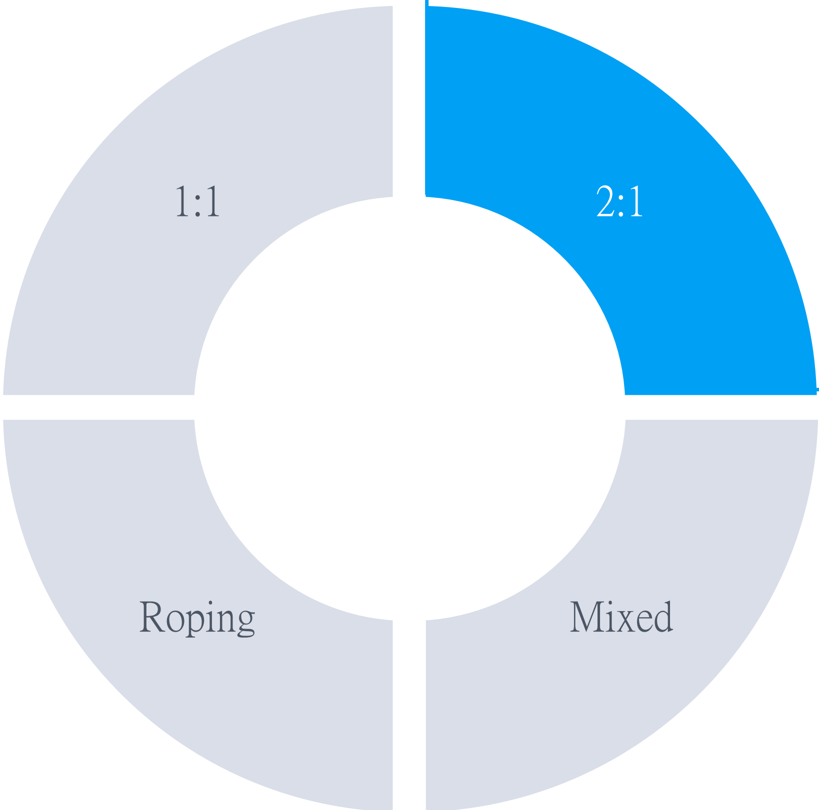


TWIN – Pulley System



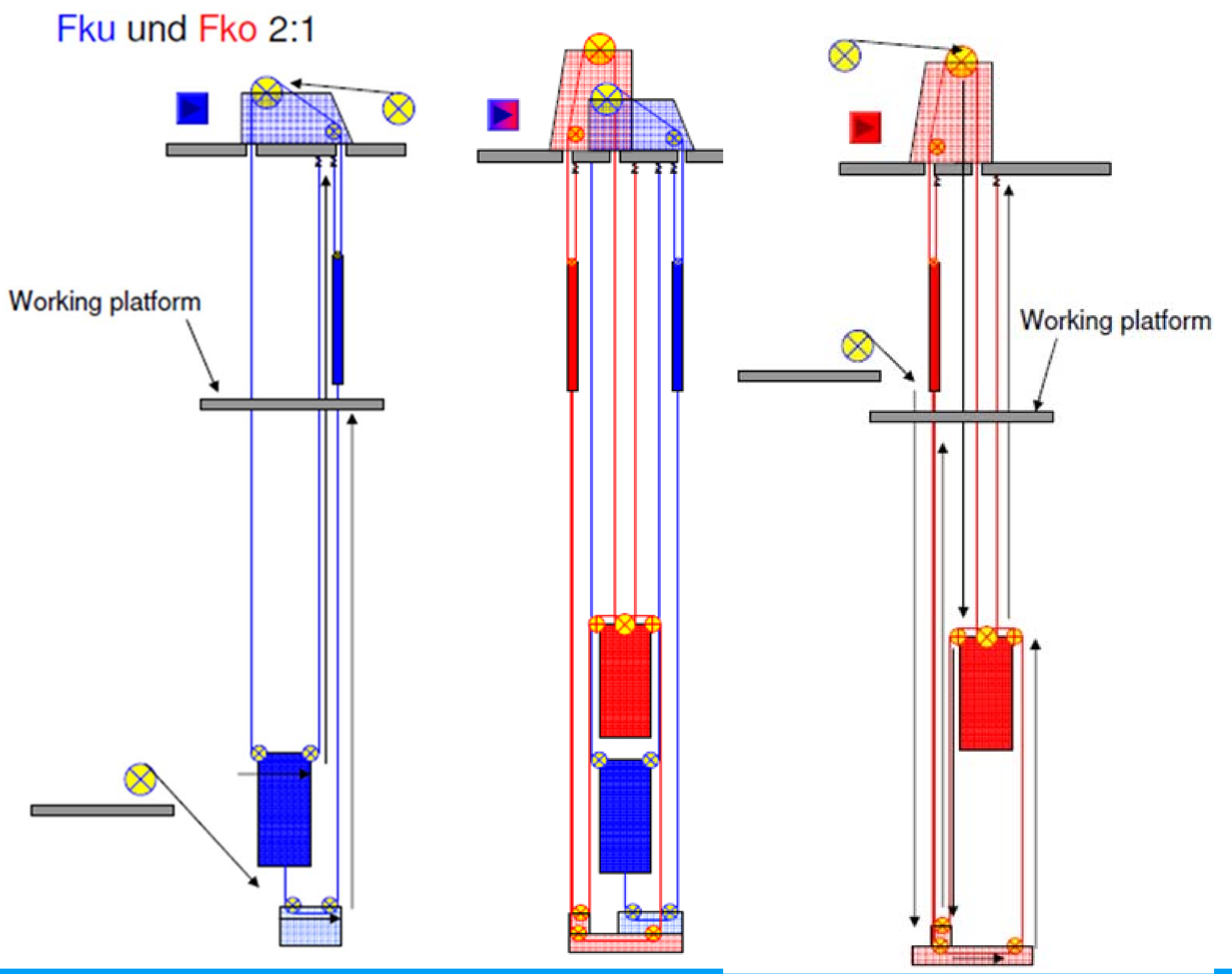
TWIN – 1:1 Upper Car and 1:1 Lower Car

TWIN – Pulley System Arrangement



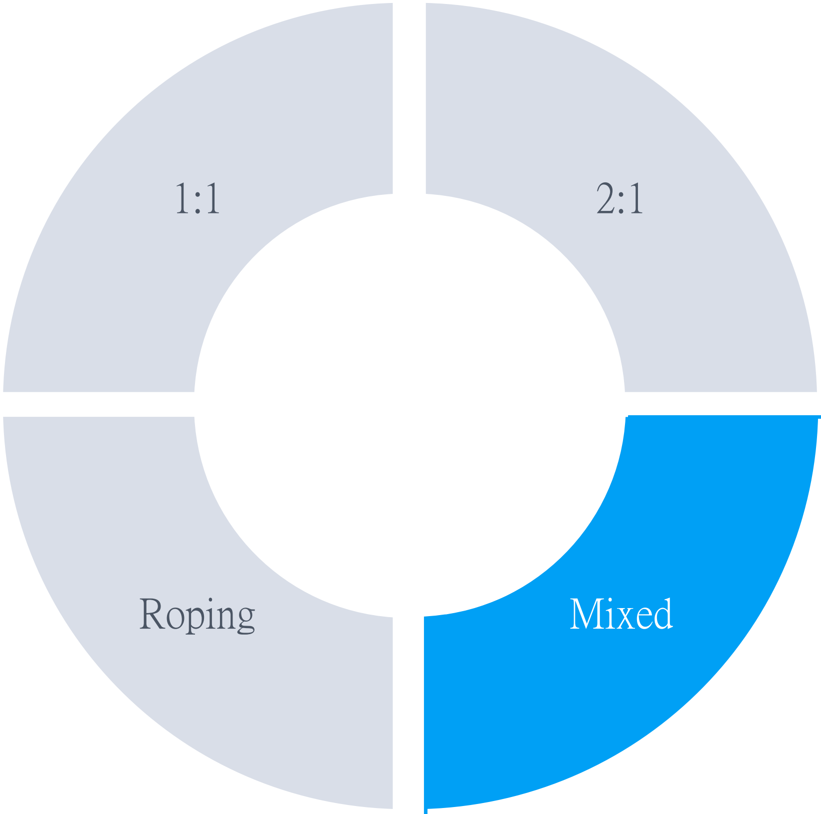
- 2:1 Upper Car
- 2:1 Lower Car

TWIN – Pulley System



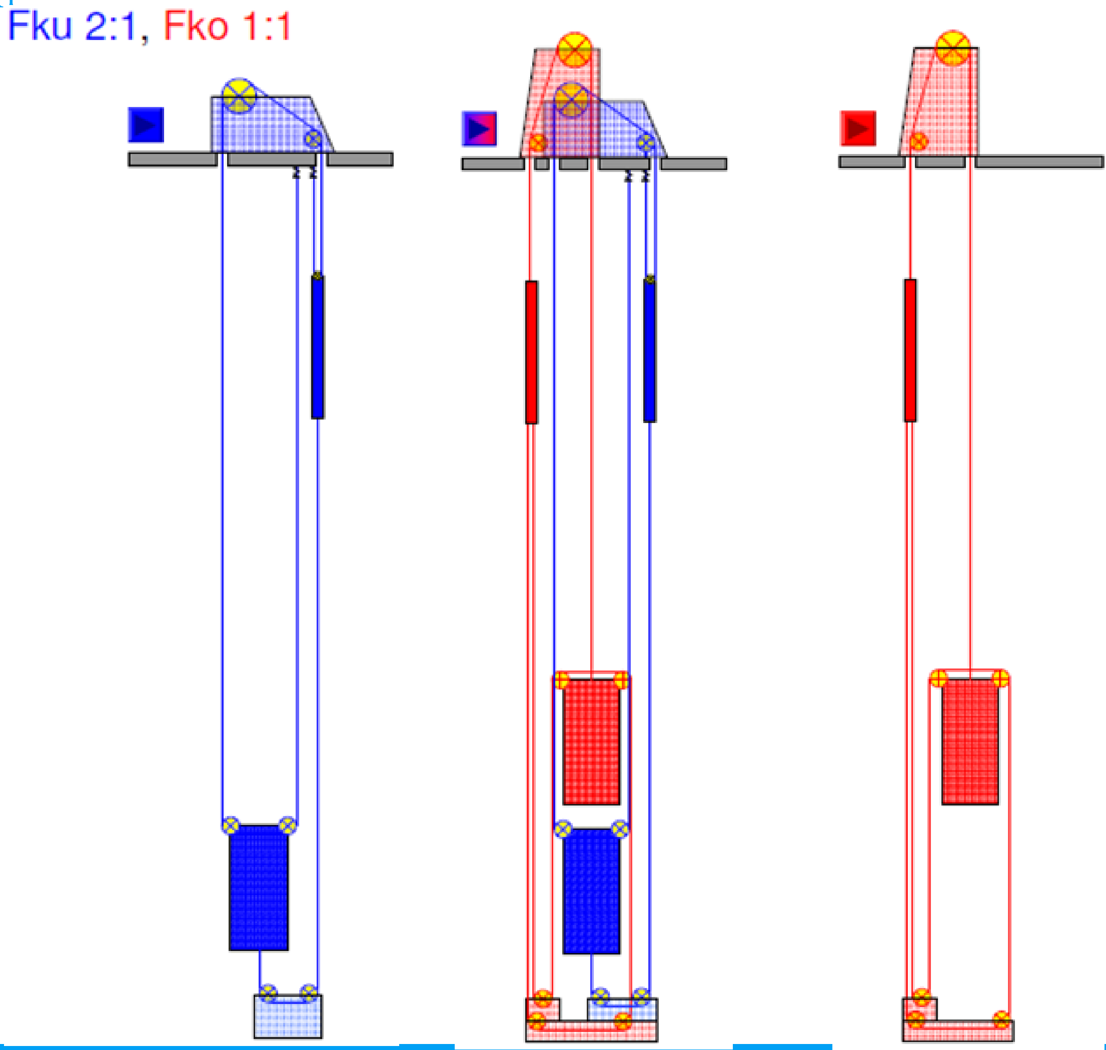
TWIN – 2:1 Upper Car and 2:1 Lower Car

TWIN – Pulley System Arrangement



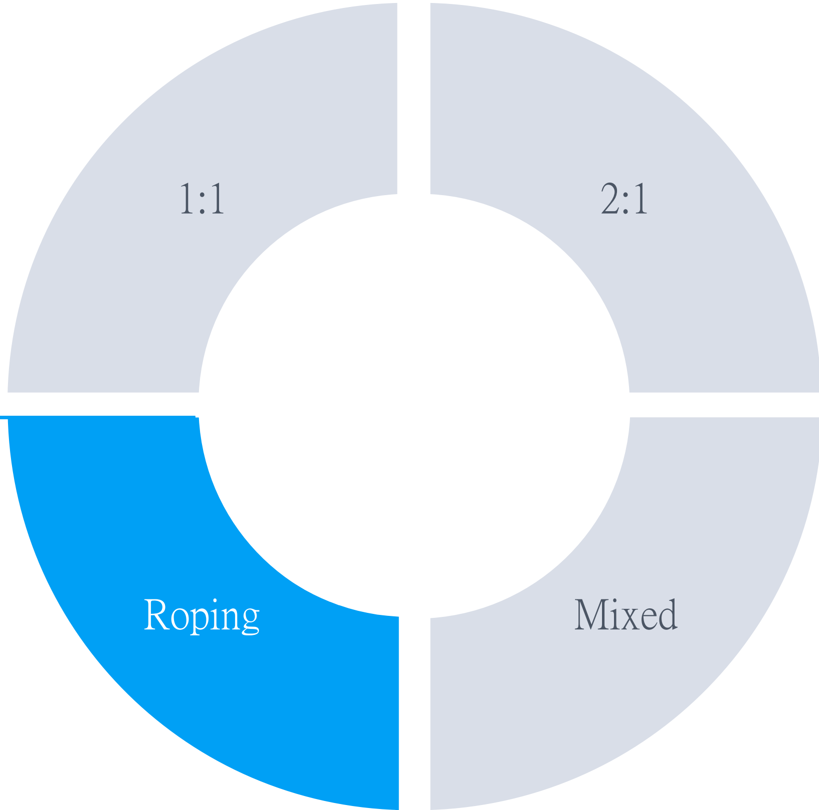
- 1:1 Upper Car
- 2:1 Lower Car

TWIN – Pulley System



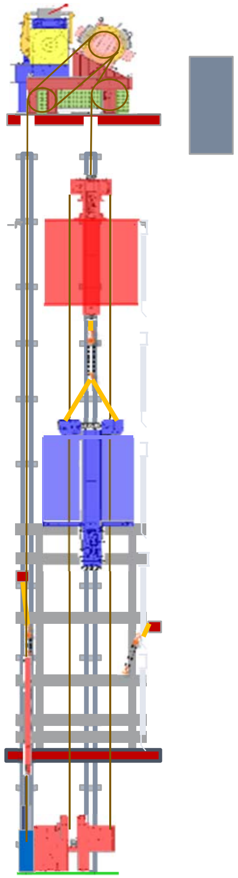
TWIN – 1:1 Upper Car and 2:1 Lower Car

TWIN – Pulley System Arrangement

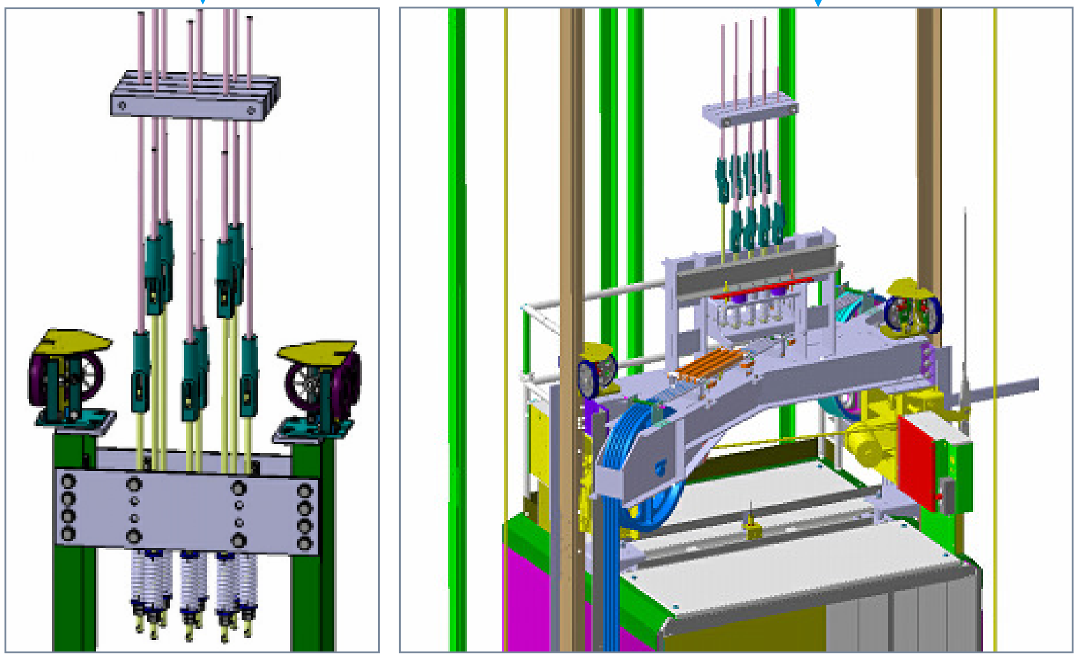


- 1:1 Upper Car
- 2:1 Lower Car

TWIN – Roping

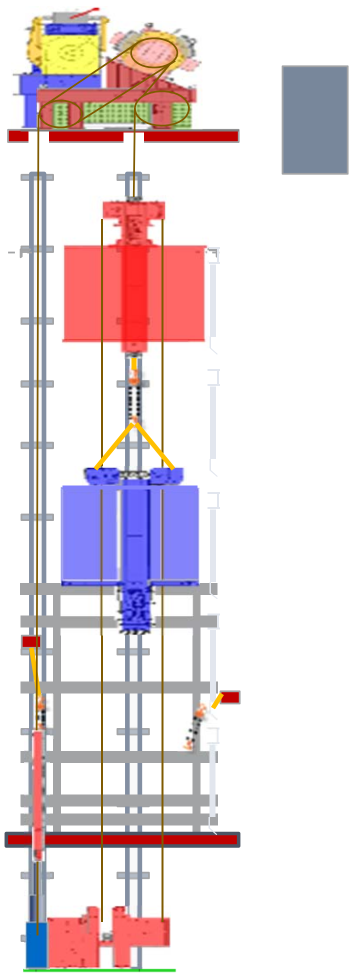


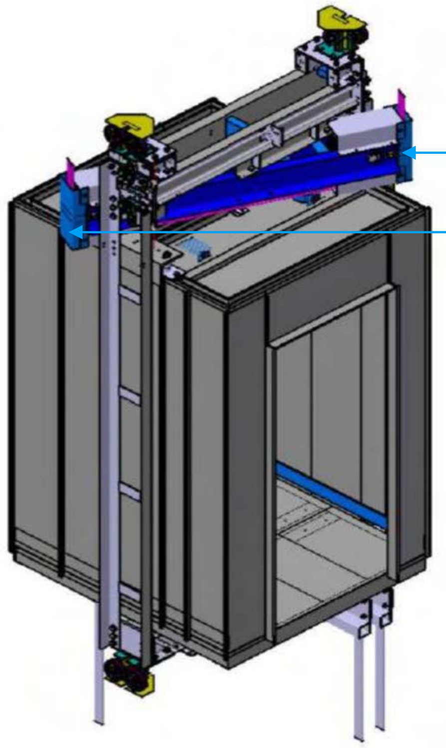
Roping for Upper Car (1:1 roping)



TWIN – Upper Car

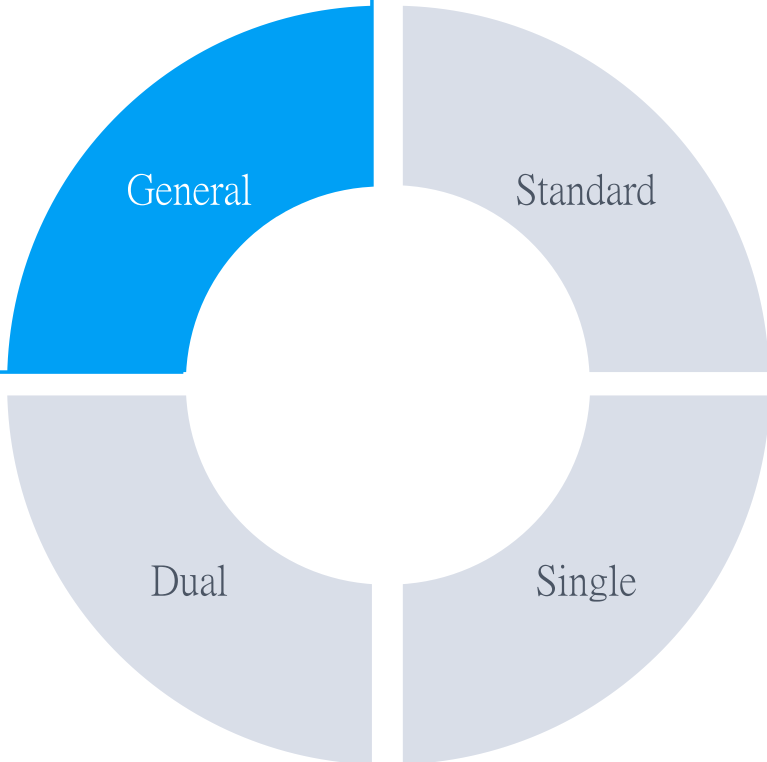
TWIN – Roping



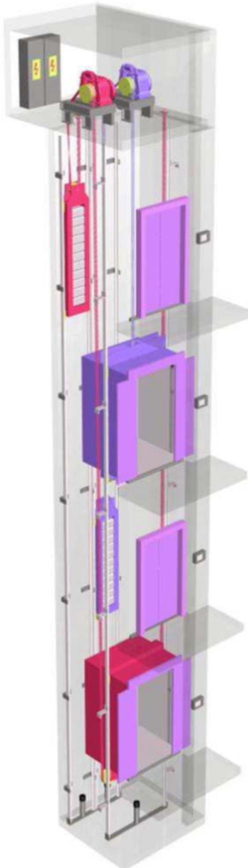


TWIN – Machine Room and Hoistway Arrangement

- General Arrangement:
  - Machine room
  - Hoistway
  - Counterweight

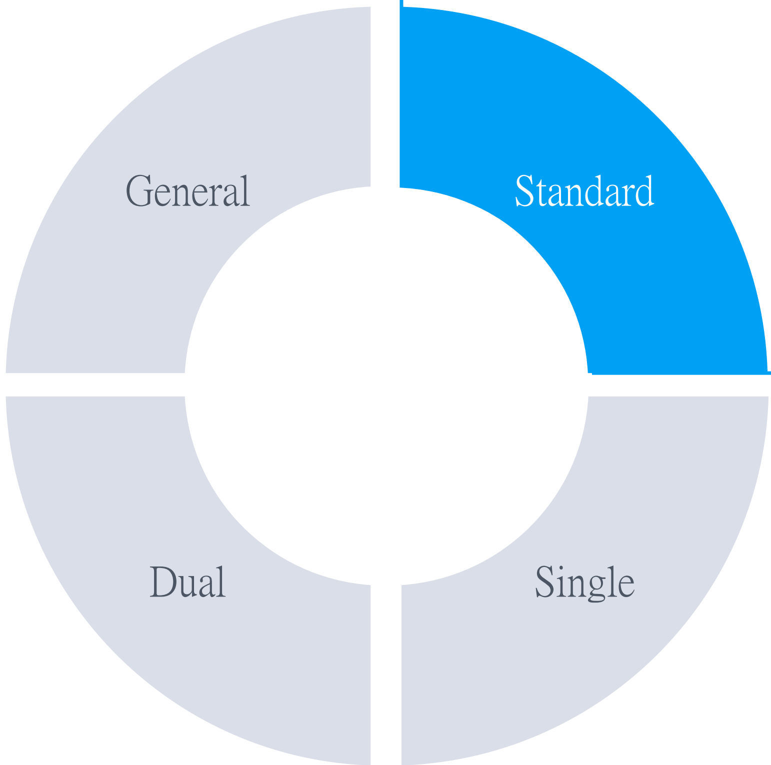


TWIN – General Arrangement



TWIN Arrangement: Machine Room, Hoistway, and Counterweight

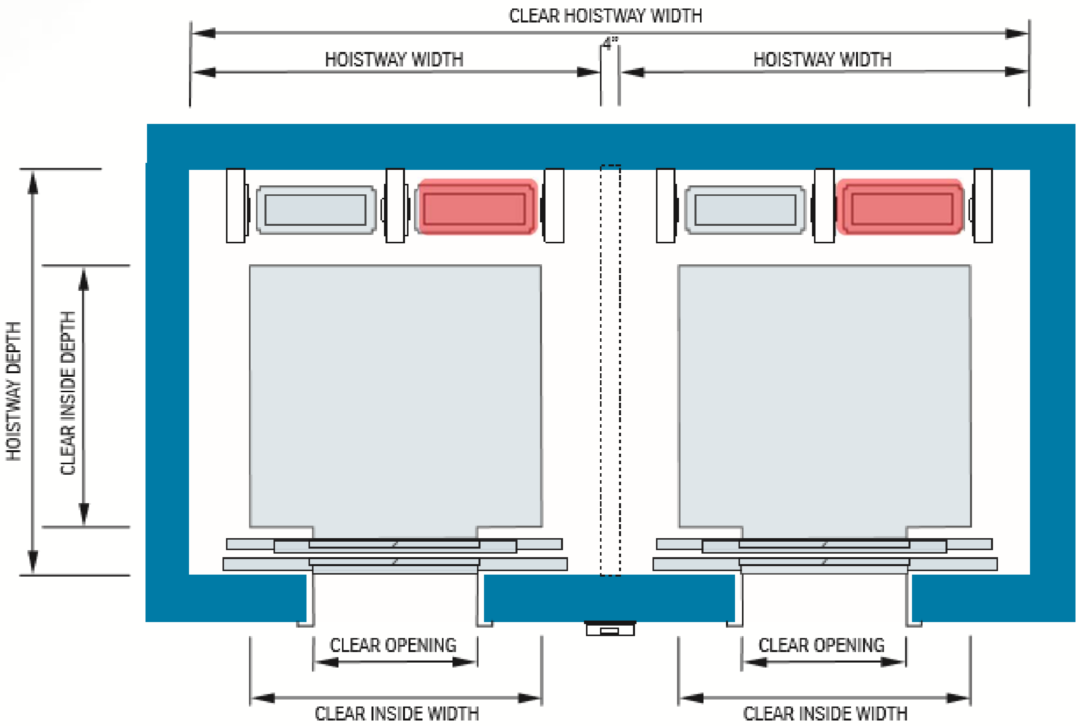
TWIN – Machine Room and Hoistway Arrangement



- Standard Arrangement
  - Hoistway
  - Drive and Electricals

TWIN – Standard Arrangement

Rated Load (kg)	1150	1350	1600	1800
Shaft width (mm)	5,800	5,800	5,800	6,400
Shaft depth (mm)	2,900	2,900	2,900	3,200
Car width (mm)	2,300	2,400	2,700	2,700
Car depth (mm)	1,300	1,400	1,600	1,600
Door width (mm)	1,000	1,000	1,000	1,000 / 1,200

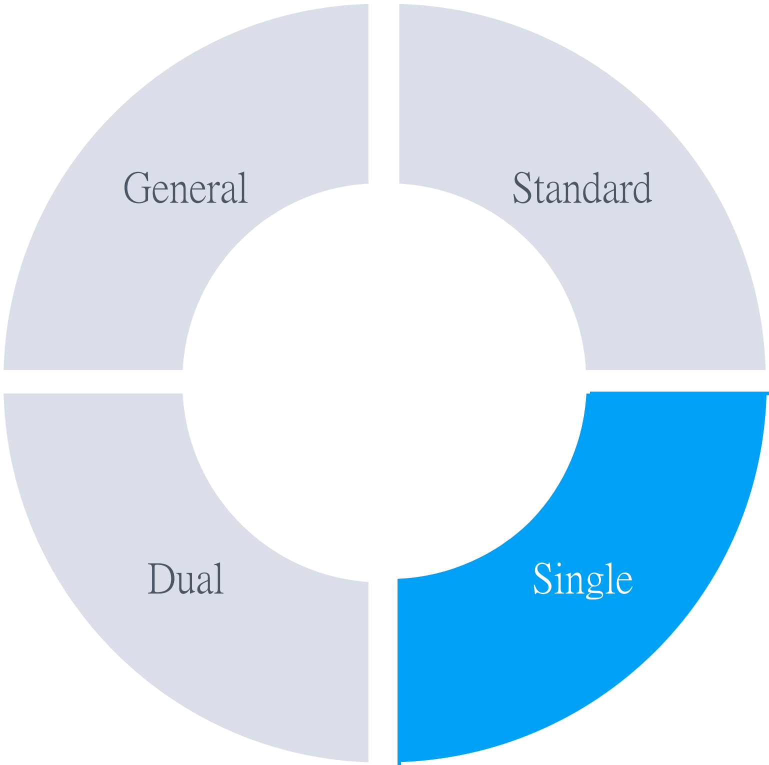


TWIN – Hoistway

TWIN – Standard Arrangement

Rated Load (kg)	1150		1350		1600		1800	
Speed (U/L) m/s	4.0 / 2.5	6.0 / 4.0	4.0 / 2.5	6.0 / 4.0	4.0 / 2.5	6.0 / 4.0	4.0 / 2.5	6.0 / 4.0
Starts / hours	240	240	240	240	240	240	240	240
Max power (U/L) kVA	157 / 97	116 / 157	158 / 97	126 / 158	158 / 98	134 / 158	159 / 98	141 / 159
Nominal current (U/L) A	50 / 33	51 / 50	57 / 38	82 / 57	65 / 43	94 / 65	73 / 48	105 / 73
Starting current (U/L) A	199 / 123	148 / 199	199 / 124	159 / 199	201 / 124	171 / 201	201 / 124	180 / 201

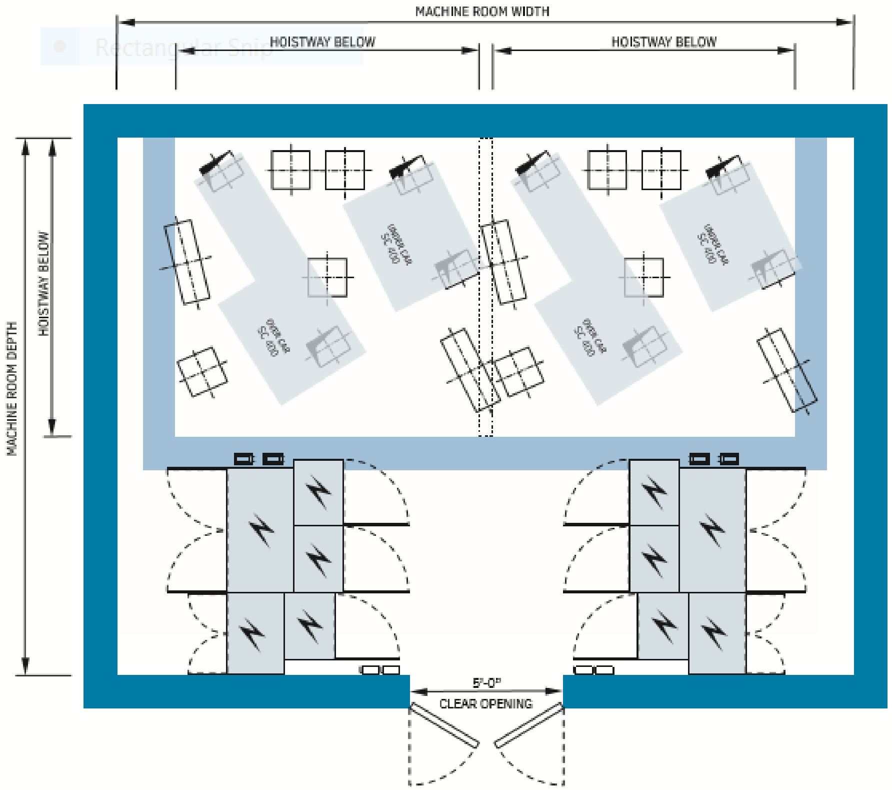
TWIN – Machine Room and Hoistway Arrangement



- Single Machine Room Arrangement
  - Machine Room
  - Hoistway

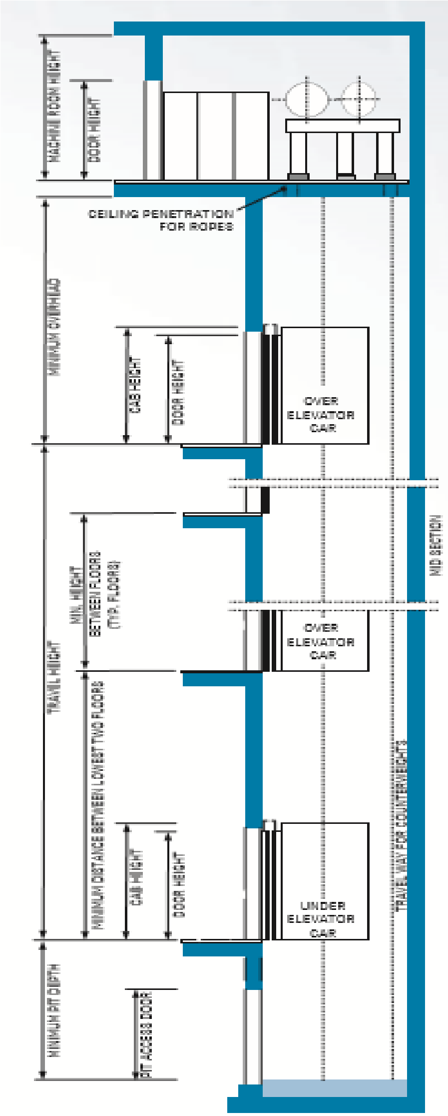
TWIN – Single Level Machine Room Arrangement

Rated Load (kg)	1150	1350	1600	1800
M/C room width (mm)	7,000	7,000	7,000	7,600
M/C room depth (mm)	5,400	5,600	5,800	5,800
M/C room height (mm)	2,600	2,600	2,600	2,600



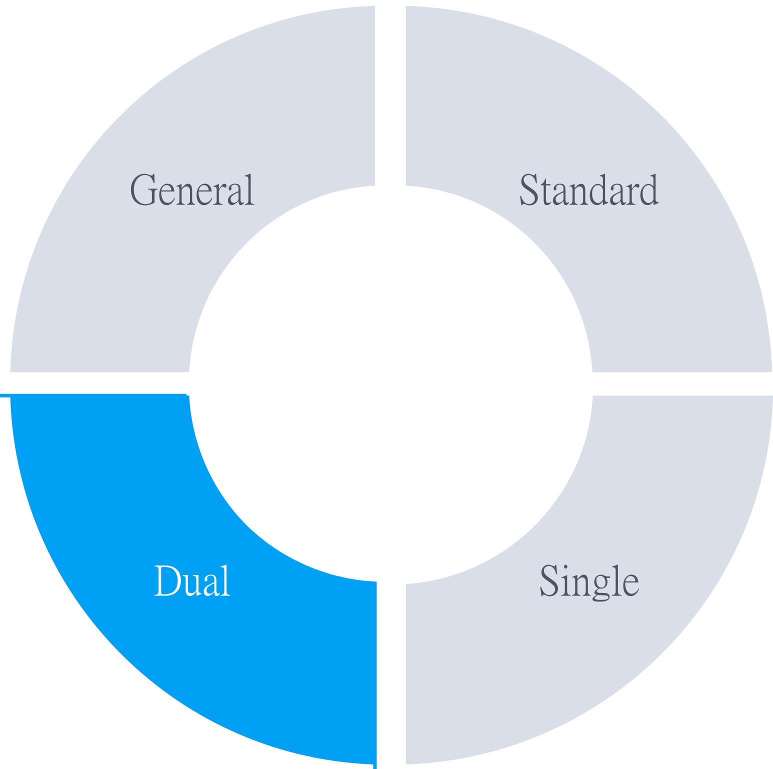
TWIN – Single Level Machine Room Arrangement

Rated Load (kg)	1150	1350	1600	1800
Rated speed (U) m/s	4.0	4.0	4.0	4.0
Rate speed (L) m/s)	2.5	2.5	2.5	2.5
Min overhead (mm)	5,700	5,700	5,700	5,700
Max travel (m)	150	150	150	150
Pit depth (mm)	4,000	4,000	4,000	4,000
Min height of typical floor (mm)	2,750	2,750	2,750	2,750
Min height lowest 2 floors (mm)	6,000	6,000	6,000	6,000



TWIN – Hoistway

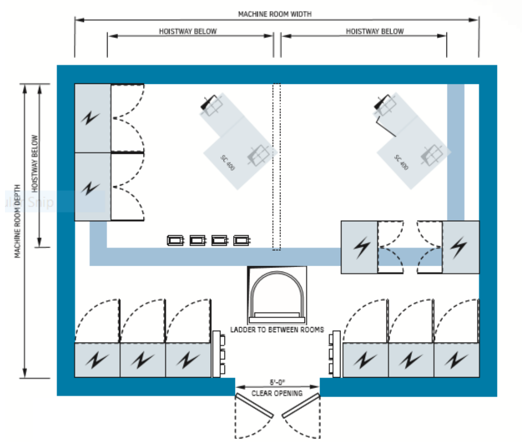
TWIN – Machine Room and Hoistway Arrangement



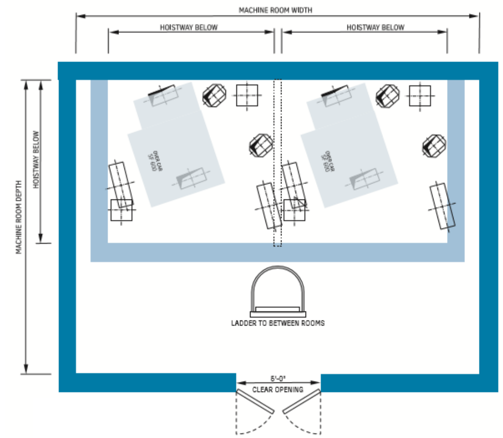
- Dual Machine Rooms Arrangement
  - Machine Rooms
  - Hoistway

TWIN – Dual Level Machine Room Arrangement

Rated Load (kg)	1150	1350	1600	1800
M/C room width Level 1 & 2 (mm)	7,000	7,000	7,000	7,500
M/C room depth Level 1 & 2 (mm)	4,900	5,000	5,300	5,300
M/C room height Level 1 (mm)	3,100	3,100	3,100	3,100
M/C room height Level 2 (mm)	2,600	2,600	2,600	2,600



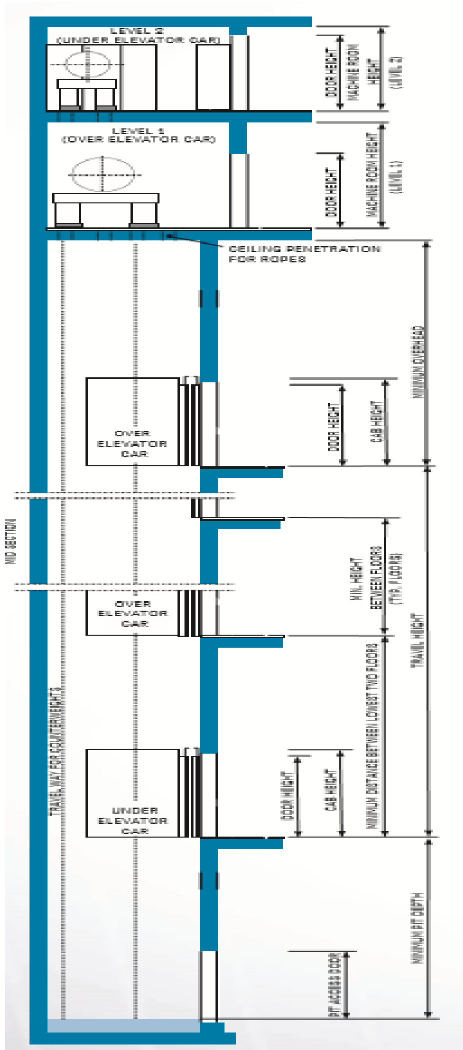
Upper M/C room



Lower M/C room

TWIN – Dual Level Machine Room Arrangement

Rated Load (kg)	1150	1350	1600	1800
Rated speed (U) m/s	6.0	6.0	6.0	6.0
Rated speed (L) m/s	4.0	4.0	4.0	4.0
Min overhead (mm)	6,000	6,000	6,000	6,000
Max travel (m)	150	150	150	150
Pit depth (mm)	4,600	4,600	4,600	4,600
Min height typical floors (mm)	2,500	2,500	2,500	2,500
Min height lowest 2 floors (mm)	6,300	6,300	6,300	6,300



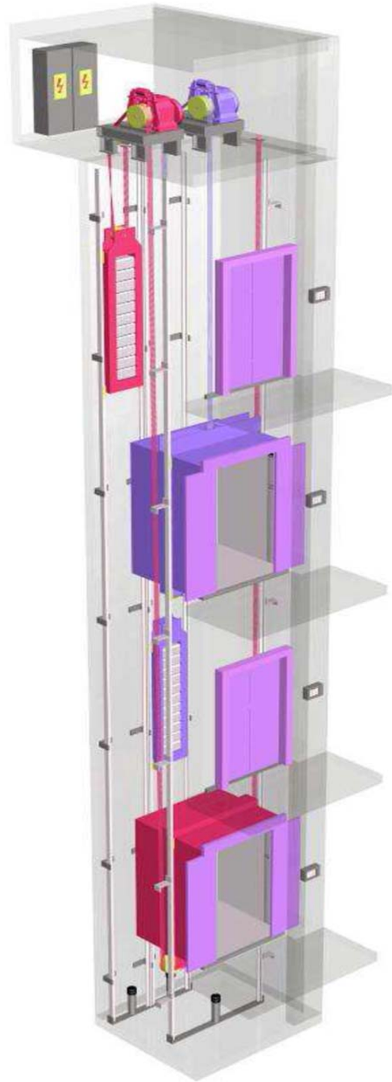
TWIN – Hoistway

Safety Provision – Roping System

Roping System

- The adoption of different and independent driving and roping system, for instance, 1:1 for upper car & 2:1 for lower car to allow:

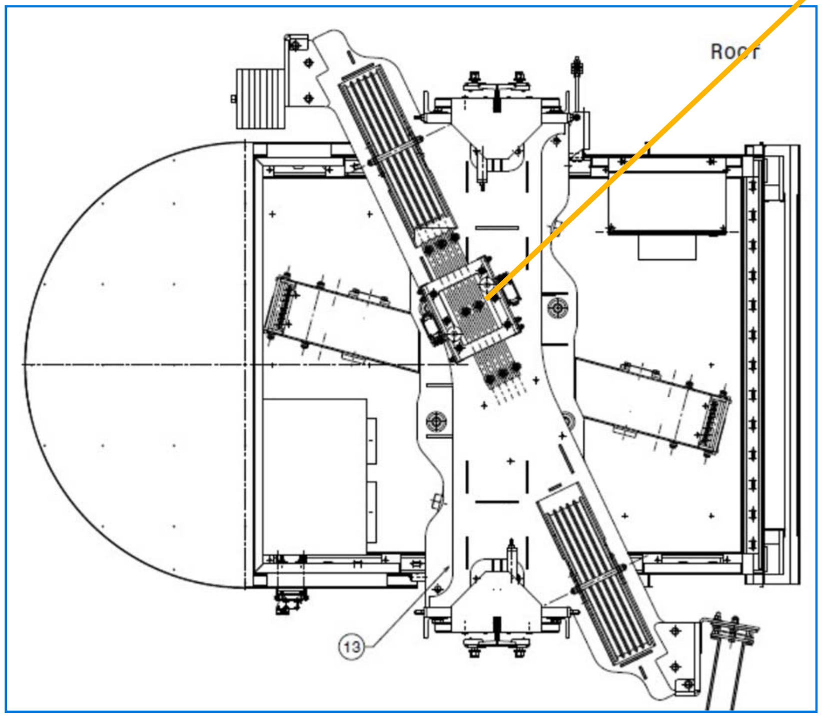
  two cars moving independently in the same shaft



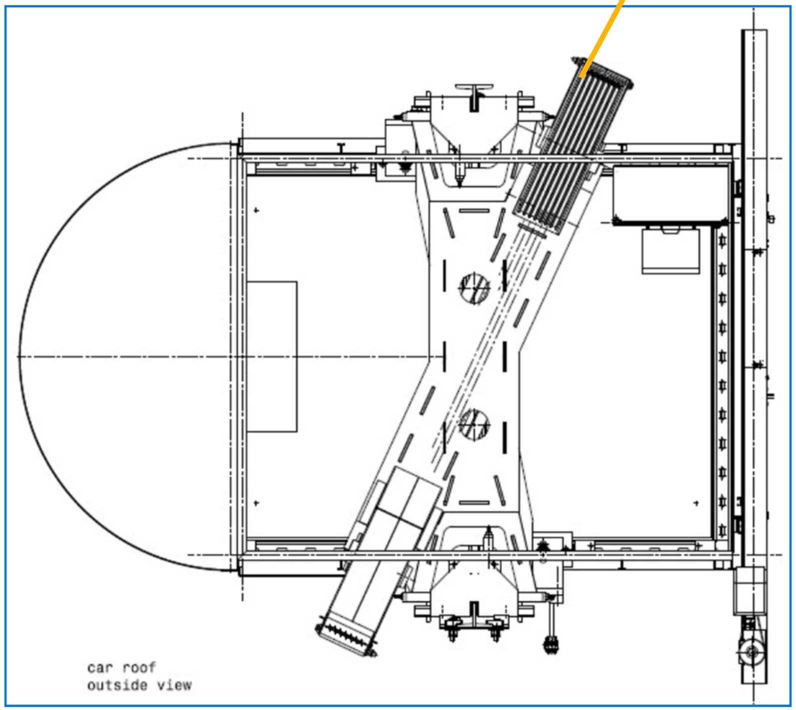
Safety Provision – Roping System

Rope anchorage for upper car

Car sling with diverter pulleys at lower beams for lower car



Upper Car



Lower Car

Safety Provision – Buffer System

Buffer System

Buffers for lower car

Buffers for counterweight of lower car

* 2nd set of buffers for counterweight of upper car also located at pit

Lower Car

Safety Provision – Independent Driving System

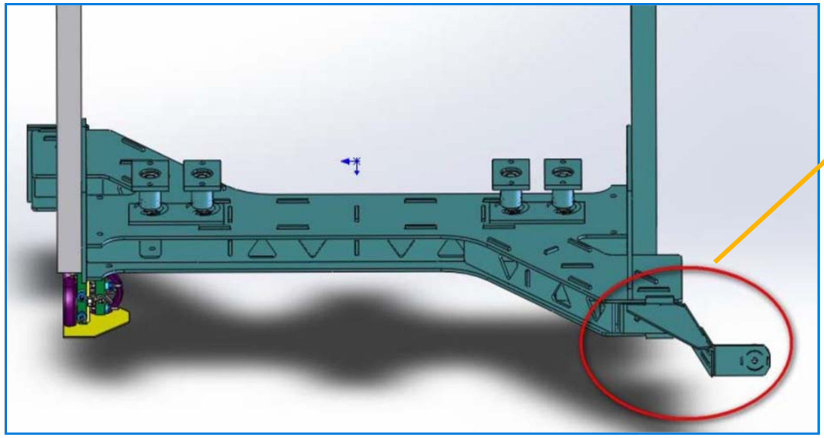
Independent Driving System

Independent motor, governor and drive mechanism for upper car (coloured separately for each car)

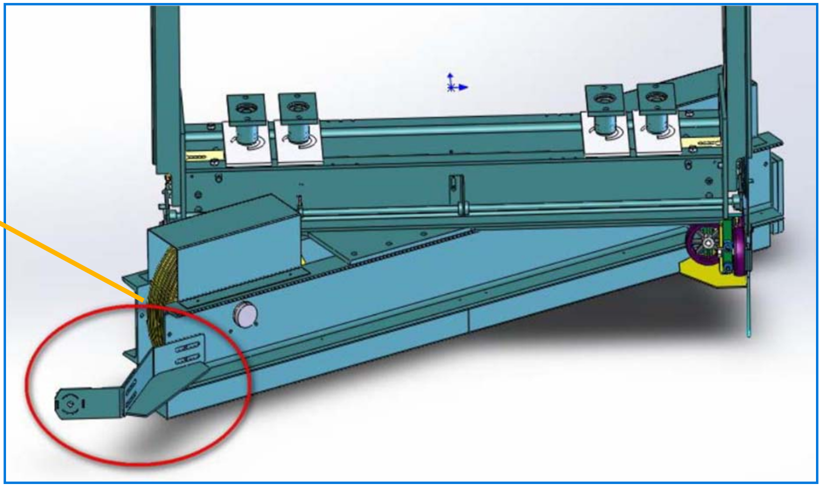
Independent drive mechanism for lower car

Safety Provision – Travelling Cable Arrangement

Travelling Cable Arrangement



Guiding device at car sling for travelling cable of upper car



Guiding device at car sling for travelling cable of lower car

Safety Provision – Braking Mechanism

Braking Mechanism

Overspeed governor & pit diverter pulley for upper car

Rope creep device

Overspeed governor & pit diverter pulley for lower car

Safety Provision – 4 Levels of Safety Integrity

4 Levels of Safety Integrity

Tolerable Hazard Rate THR per hour and per function	Safety Integrity Level
$10^{-9} \leq THR < 10^{-8}$	4
$10^{-8} \leq THR < 10^{-7}$	3
$10^{-7} \leq THR < 10^{-6}$	2
$10^{-6} \leq THR < 10^{-5}$	1

Level 1

- By use of DSC, cars are allocated to ensure safety distance between U/L cars

Level 2

- Continuous monitor and control of the minimum safety distance between U/L cars

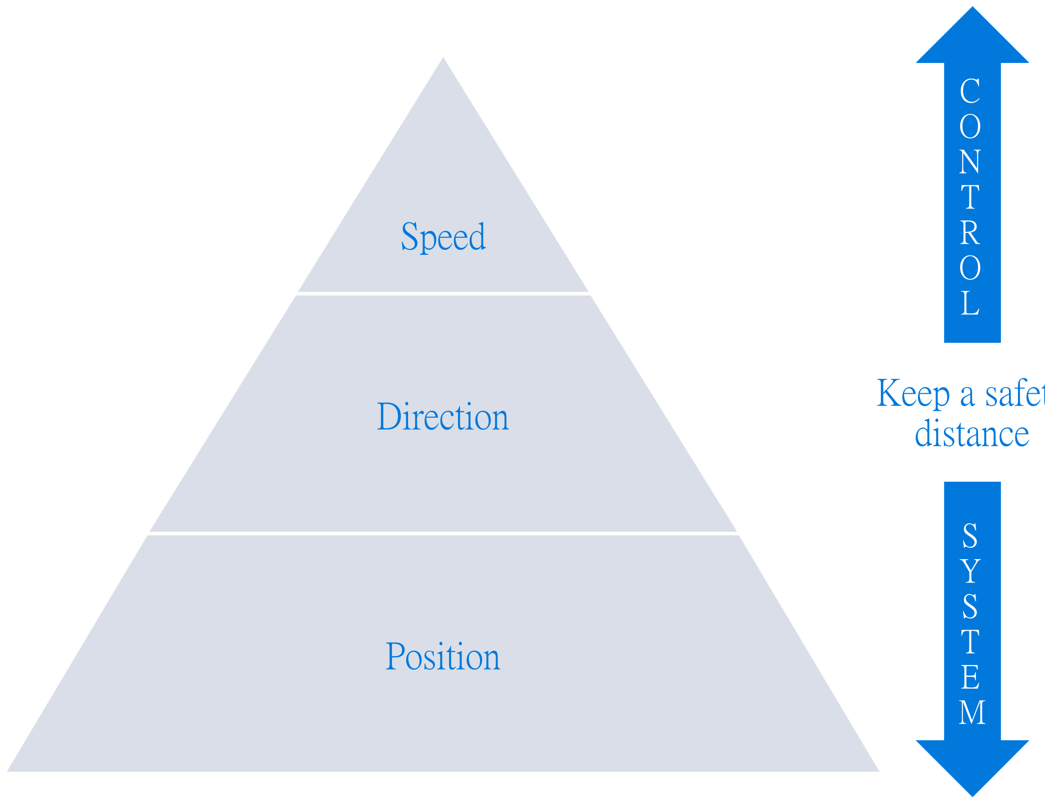
Level 3

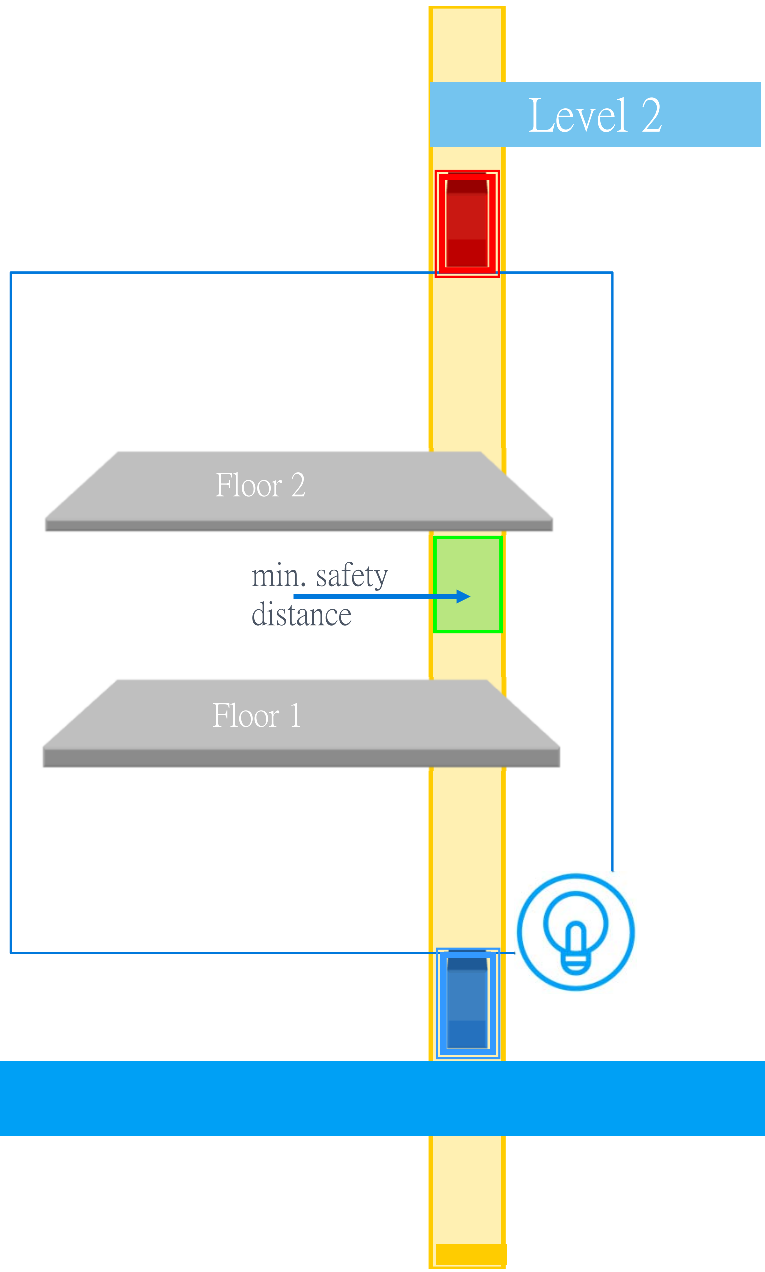
- Emergency stop

Level 4

- Activation of safety gears

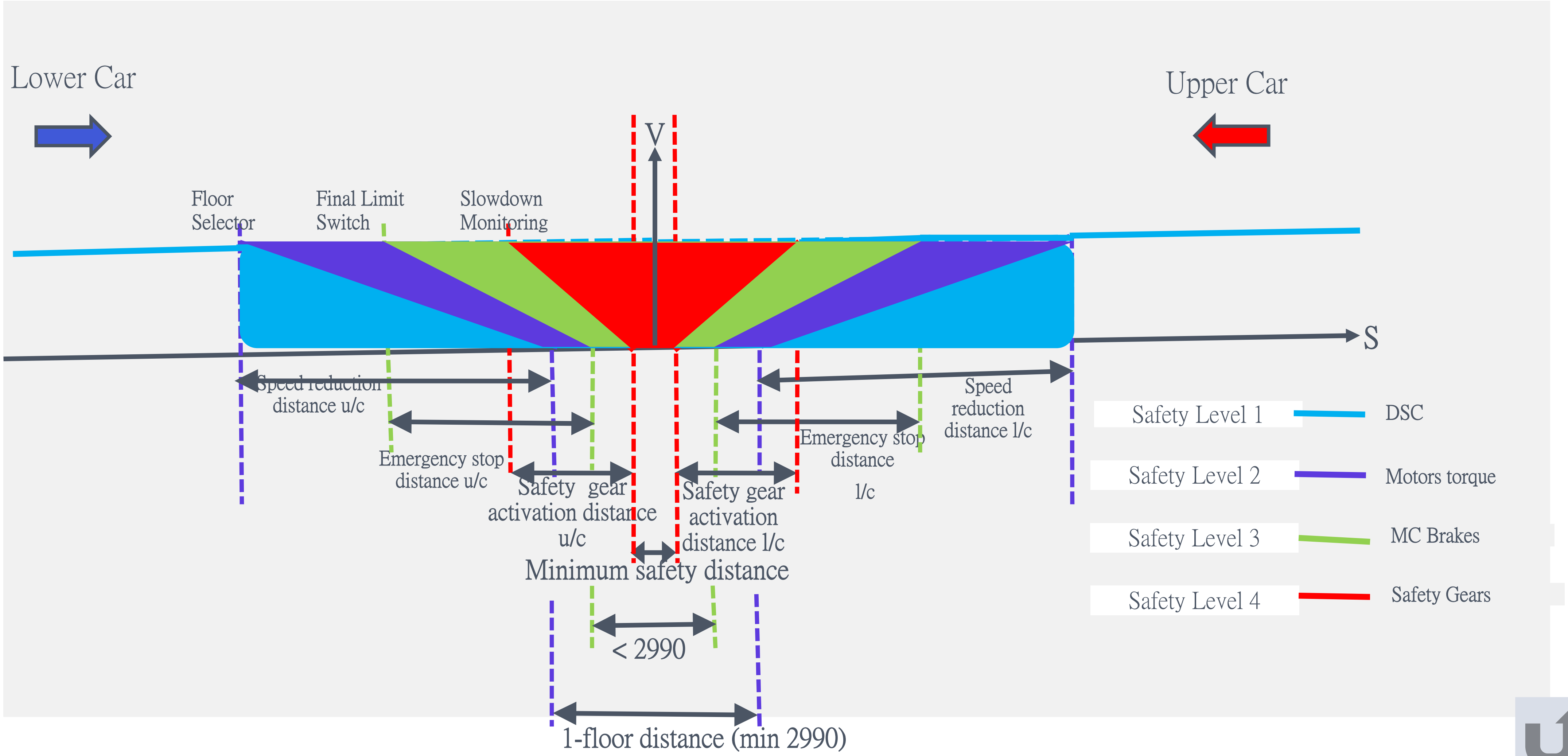
Safety Provision – 4 Levels of Safety Integrity





2nd Level of Safety Integrity

Safety Provision – 4 Levels of Safety Integrity



Safety Provision – 4 Levels of Safety Integrity

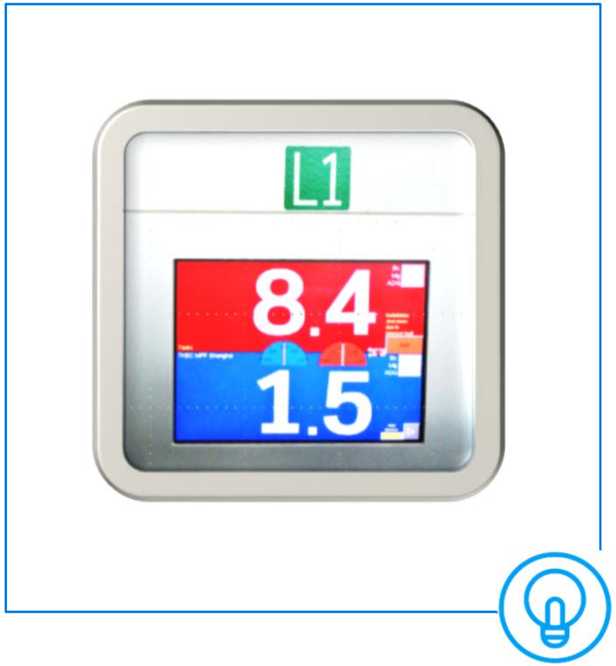
Level 4
Level 3

Safety Integrity Level 3

Fly by wire

Chemical Industry

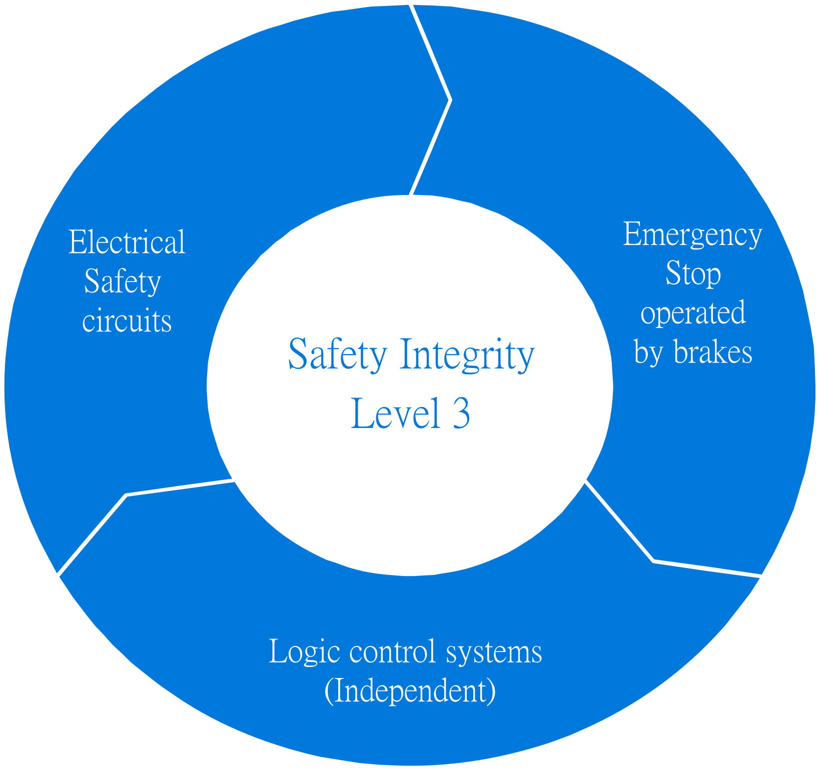
Automatic Train System



3rd & 4th Level of Safety Integrity

Safety Provision – 4 Levels of Safety Integrity

Level 3



3rd Level of Safety Integrity

Safety Provision – 4 Levels of Safety Integrity

Level 4

Level 3

Monitoring system for
1)car position,
2)speed, &
3)travel direction

Position o

Position o

Emergency stop o

Emergency stop o

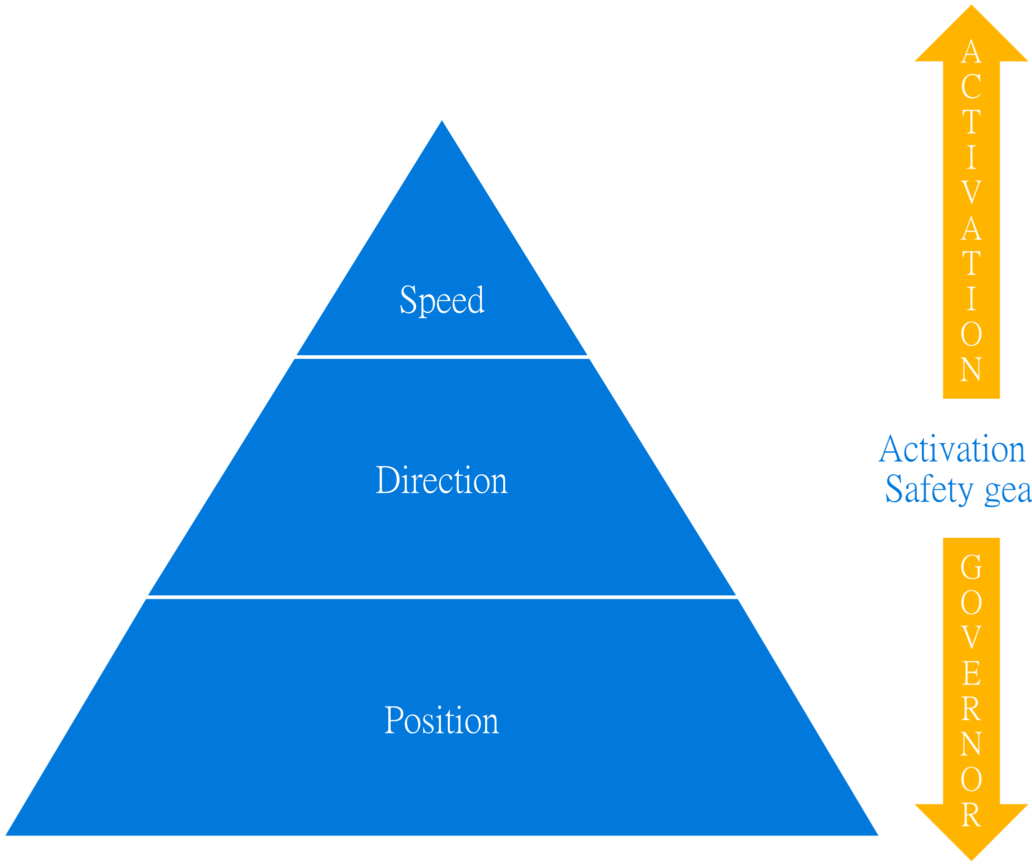
Safety gear o

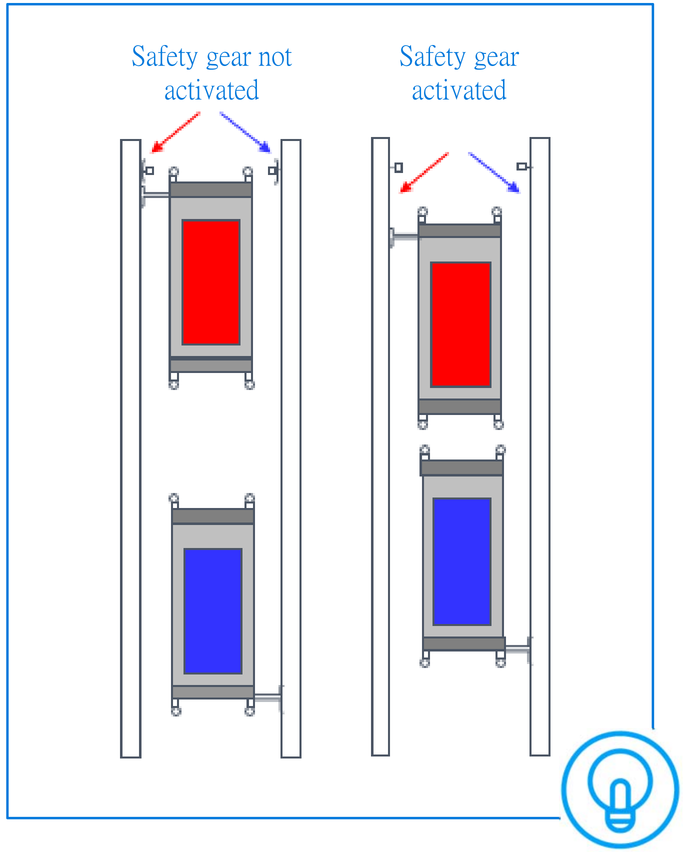
Safety gear o

4th Level of Safety Integrity

Safety Provision – 4 Levels of Safety Integrity

Level 4



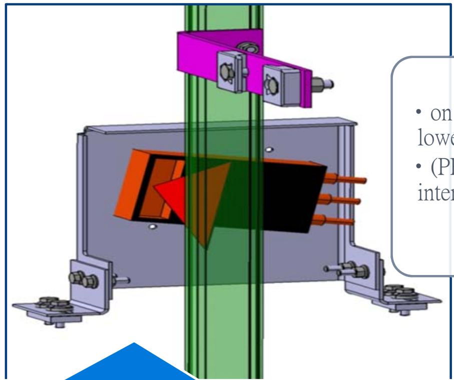


4th Level of Safety Integrity

Safety Provision – Sensor System

Sensor System

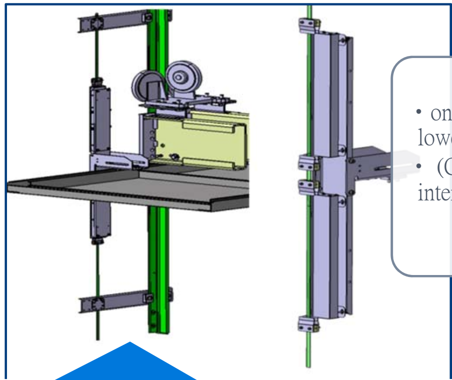
Barcode positioning system



- on upper and lower elevator car.
- (PROFIBUS interface)

Barcode positioning system BPS 34, Leuze

Magnetic absolute length measuring system



- on upper and lower elevator car.
- (CAN-bus interface)

Magnetic absolute length measuring system, ELGO-tkE

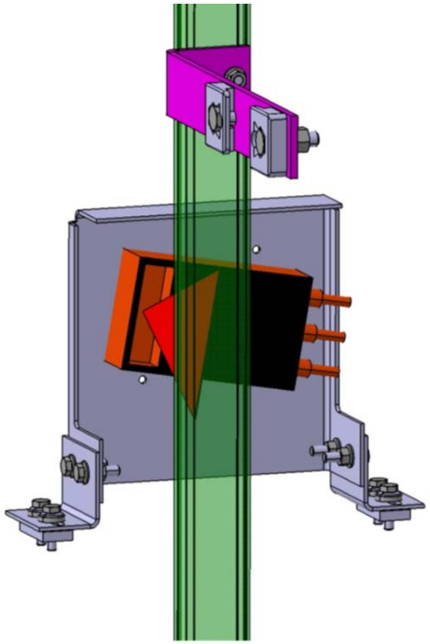
Absolute rotary encoder

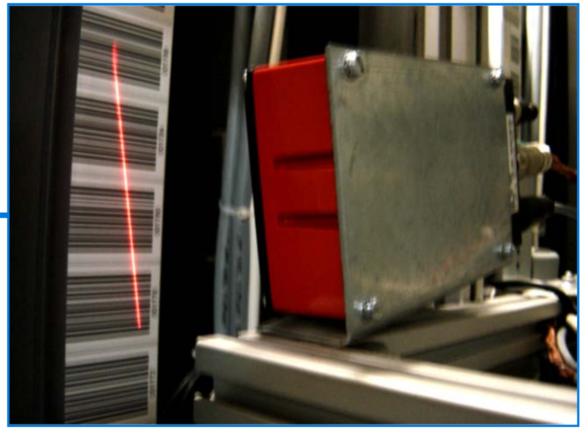
- mounted at the overspeed governor.
- (Ethernet interface)

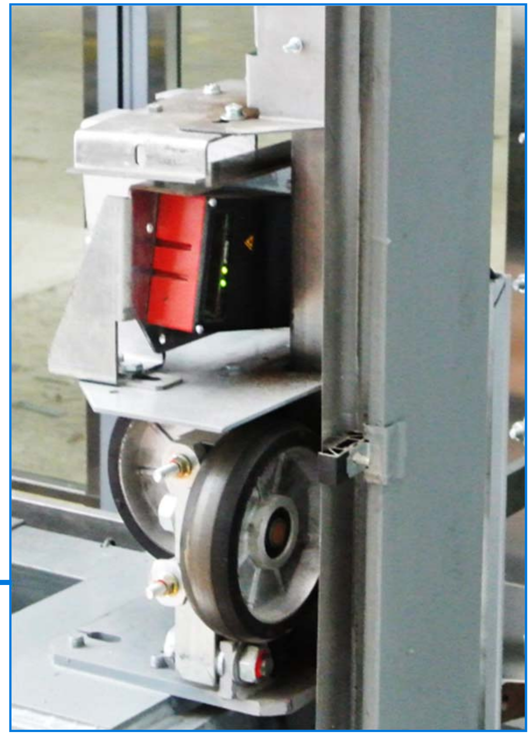
Three Sensor System: absolute rotary encoder, FRABA Posital

Safety Provision – Barcode Positioning System

Barcode Positioning System

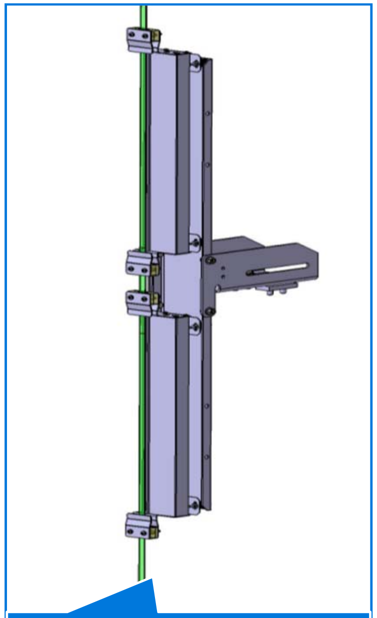




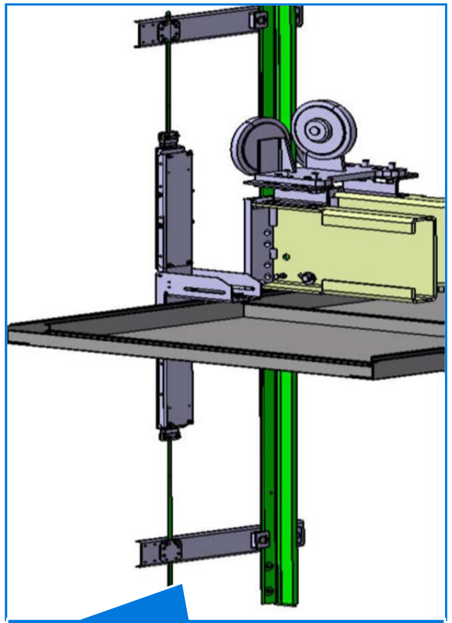


Magnetic absolute length measuring system

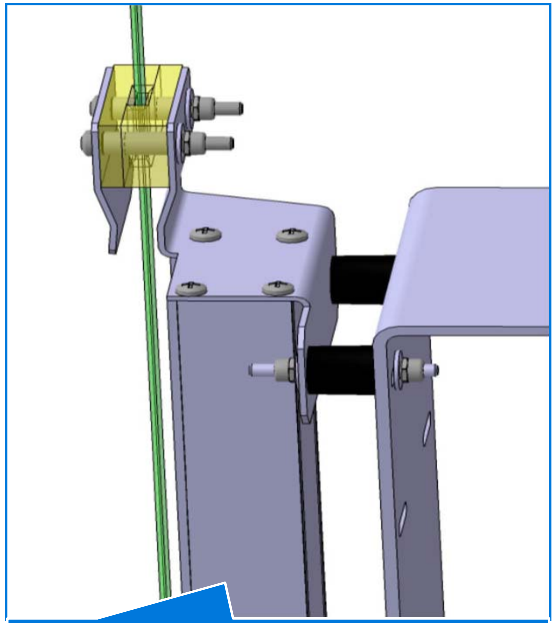
Floor selector



CPD-sensor



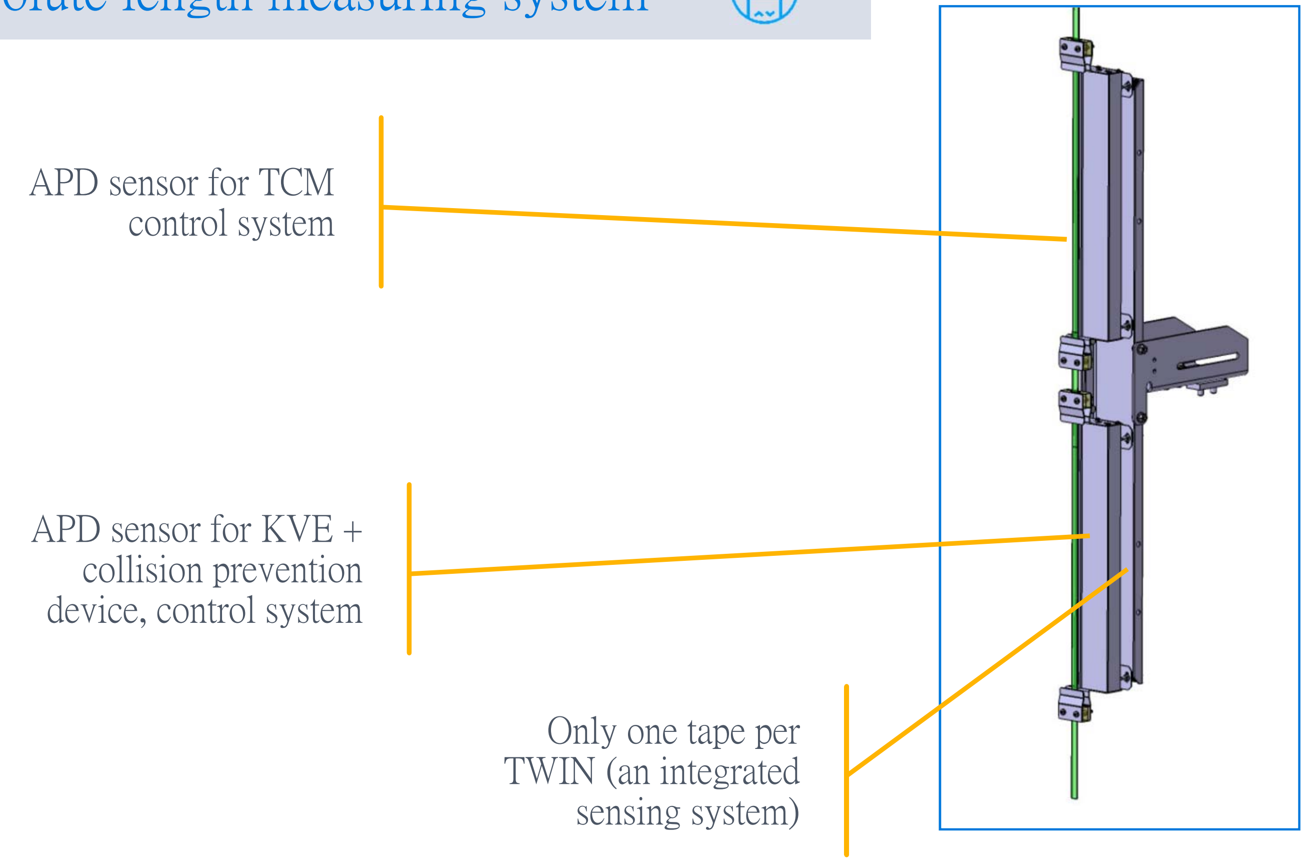
Mounting at cable duct



Guidance magnetic tape

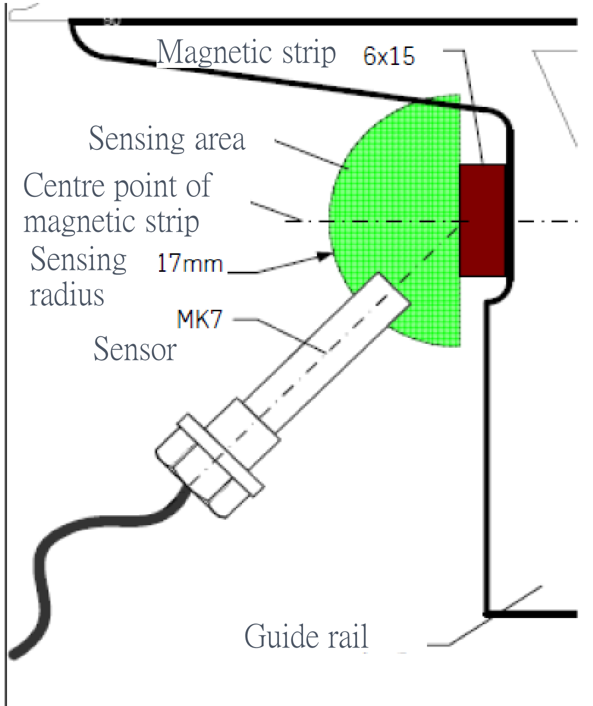
Safety Provision - Magnetic absolute length measuring system

Magnetic absolute length measuring system



Magnetic absolute length measuring system

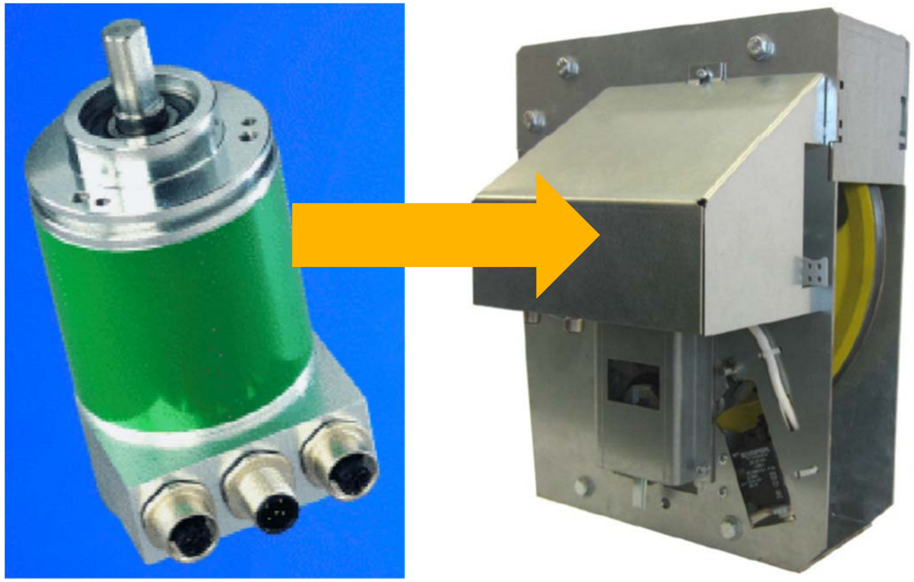
Magnetic sensing system for safe levelling for landing & relevelling



Cross sectional View

Safety Provision - Absolute rotary encoder system

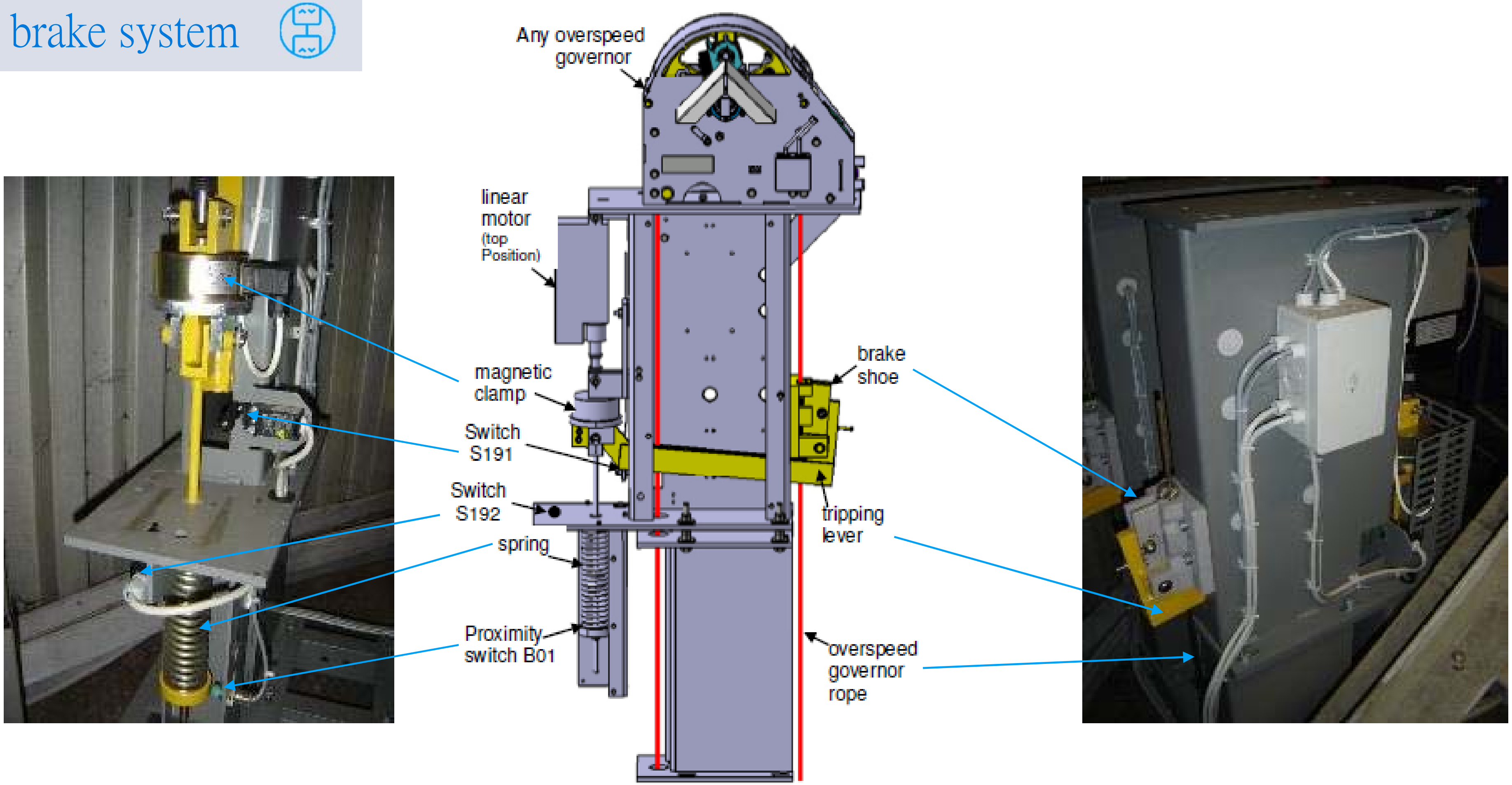
Absolute rotary encoder system



Absolute rotary encoder is mounted at the overspeed governor to monitor speed status

Safety Provision – Rope brake system

Rope brake system



Rope brake device

Rope brake open
(not actuated, lift in operation)

Brake shoe open

Motor with solenoid
in upper end position
S191: safety circuit closed

Spring tensioned,
Proximity switch actuated

Safety Provision – Rope brake device

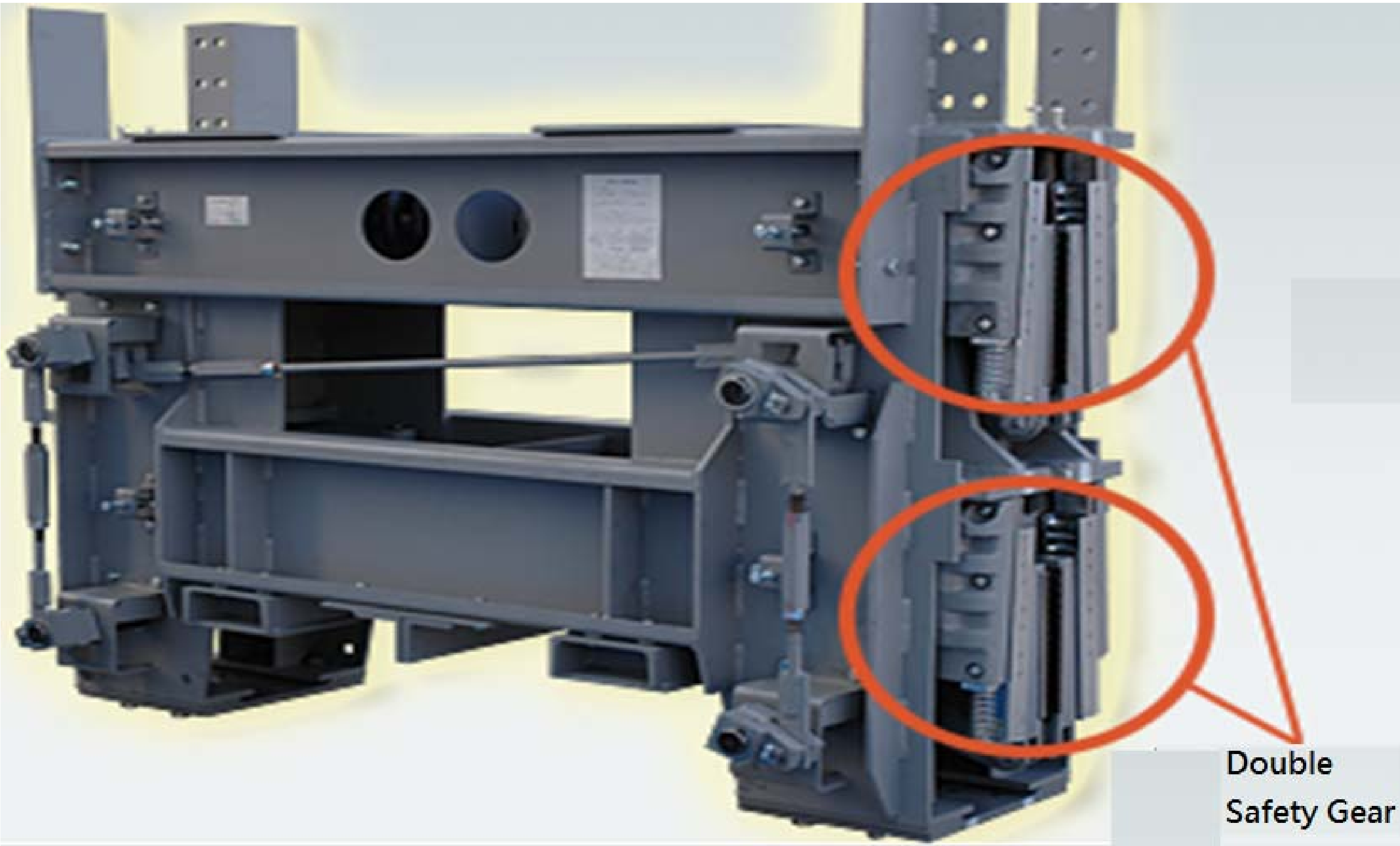
Rope brake device

Brake shoe closed
Motor with solenoid
in lower end position

Rope brake closed

Rope brake actuated
(tripped by CPD)

Double Down Safety Gear for Super High Speed Lift

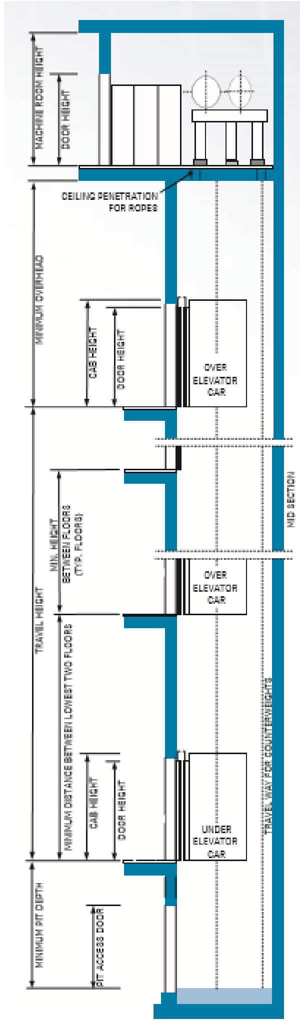


Provisions for Builder and Other Contractors

Minimum dimensions

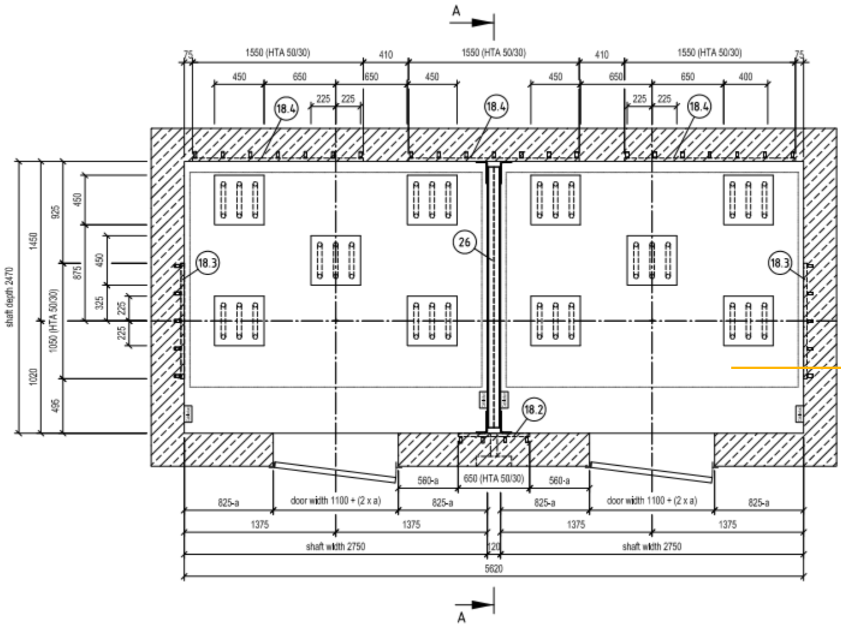
Rated Speed m/s	2.5 for (L)	4.0 for (L)	4.0 for (U)	6.0 for (U)
Overhead (mm)	N/A	N/A	5,700	6,000
Pit depth (mm)	4,000	4,600	N/A	N/A
Height of entry floor (2,600mm car height)	6,000	6,300	6,000	6,300

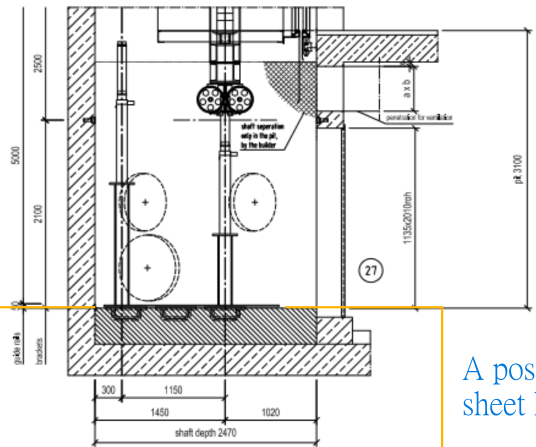
* The provisions stated are additions to the normal provisions for conventional lift



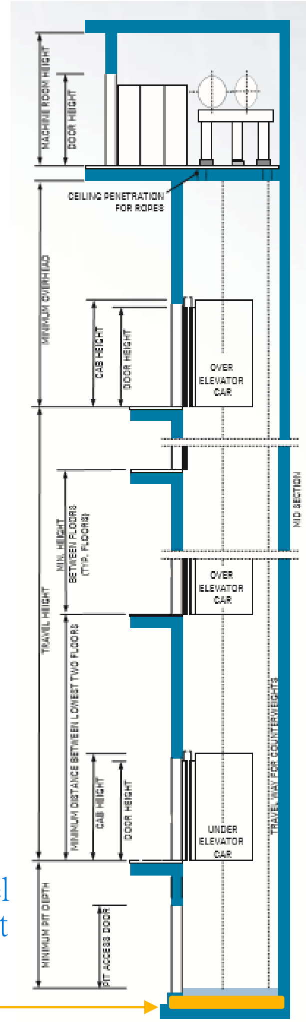
Provisions for Builder and Other Contractors

Pit Provision





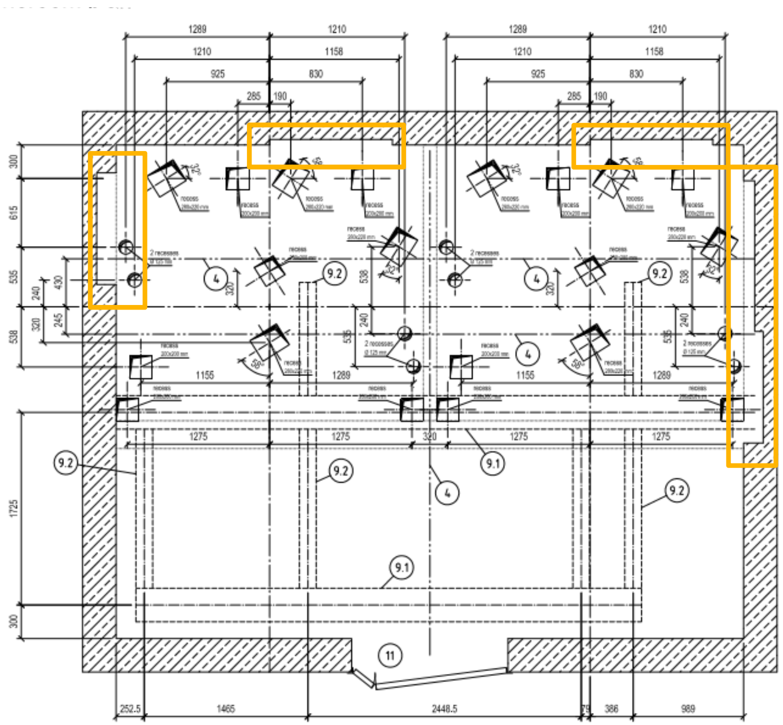
A positioning and fixing steel sheet has to be installed at pit

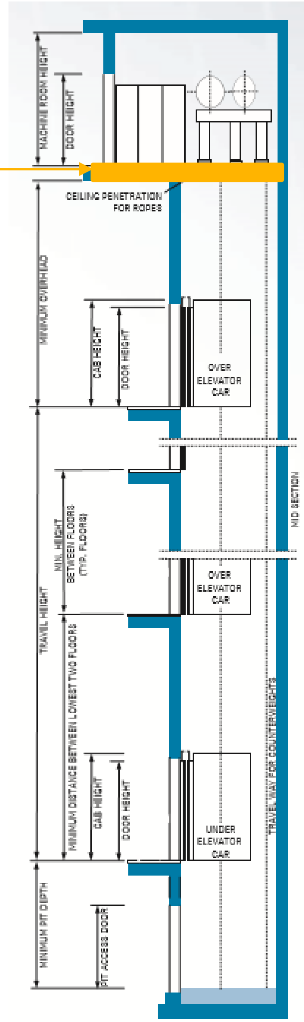


Provisions for Builder and Other Contractors

Machine Room Provision

Holes & Recess to be provided at floor slab
& side walls of m/c room

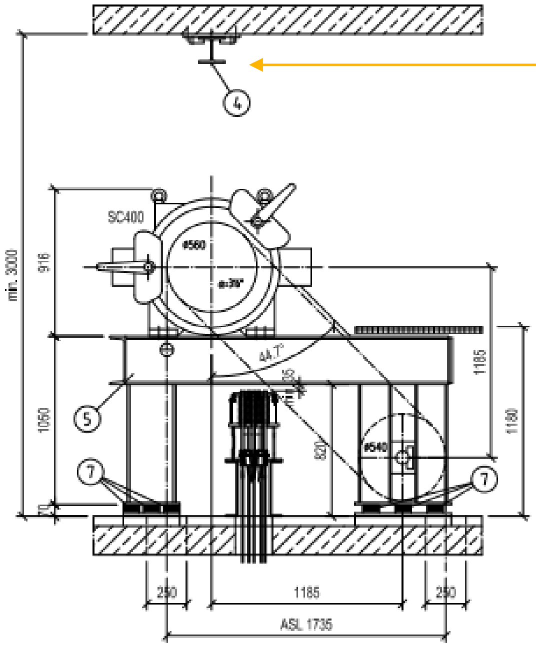


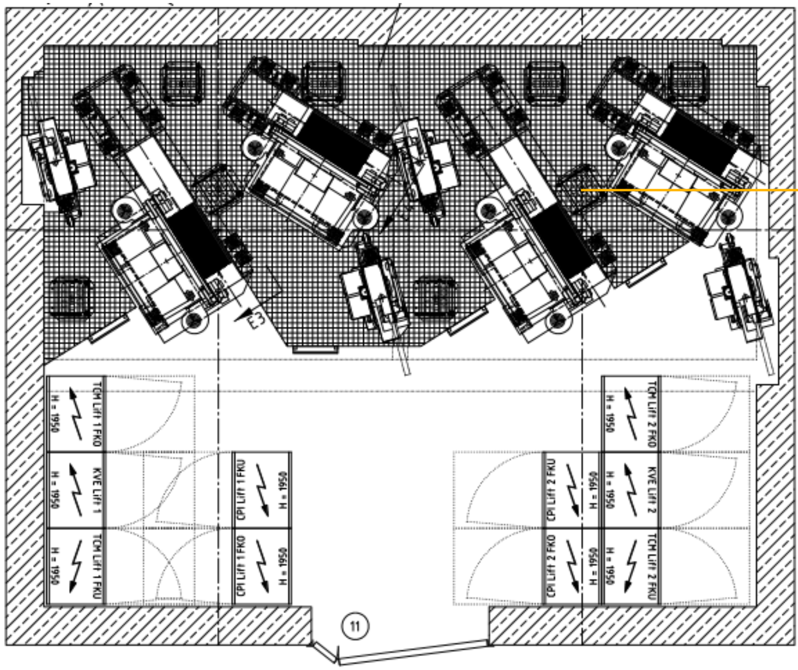


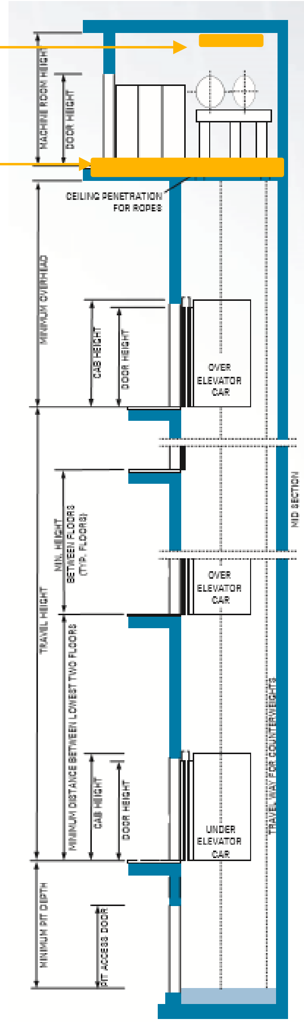
Provisions for Builder and Other Contractors

Machine Room Provision

Hoisting beams at top of m/c room and supporting beams or structure for machines







Liftshaft Splitting into 2 Dynamic Zones

TWIN Operations (雙子電梯操作):

1. Liftshaft splitting into 2 zones (井道分成兩區)

-Lower car roof as lift pit of upper zone (下機廂頂為高區井道底)

-Upper car can move in its zone independently (上機廂可在此區獨立移動)

-Upper car bottom as liftshaft ceiling of lower zone (上機廂底為低區井道頂)

-Lower car can move in its zone independently (下機廂可在此區獨立移動)

2. These 2 zones are not static but dynamic (此兩區並非靜態而是動態)

-Traditional terminal stopping, final limit & positive monitoring switches are replaced by barcode system (傳統終站制/過籠制/緊停位置制停制改用巴曲系統)

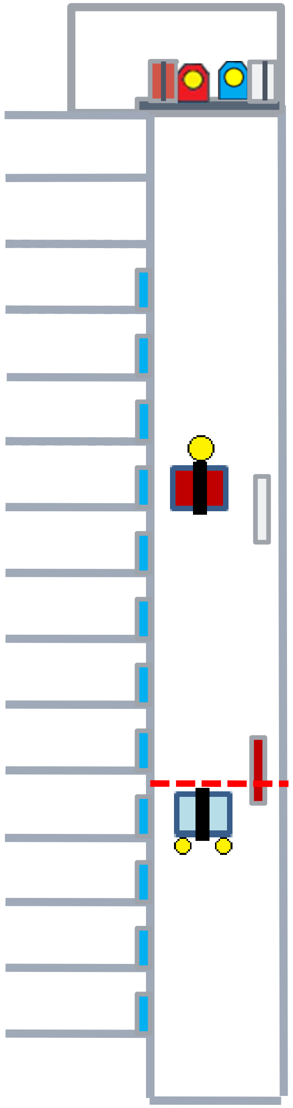
-Landing devices are replaced by magnetic absolute length measuring system (平層飛器改用磁場絕對長度量度系統-導軌翼上磁帶貼紙)

3. When traffic is slight, 1 car may park in OH or pit, if extra space is available (如有額外空間供一台機廂在低交通量時停泊在井底或井道頂)

- This car can serve all landings (此機廂可服務所有樓層)

-This operation mode can save energy (此操作模式可節省能源)

4. During morning up-peak, both cars may move synchronously to handle high traffic flow (早晨交通頂峰時，兩台機廂可同步移動以應付高流量)



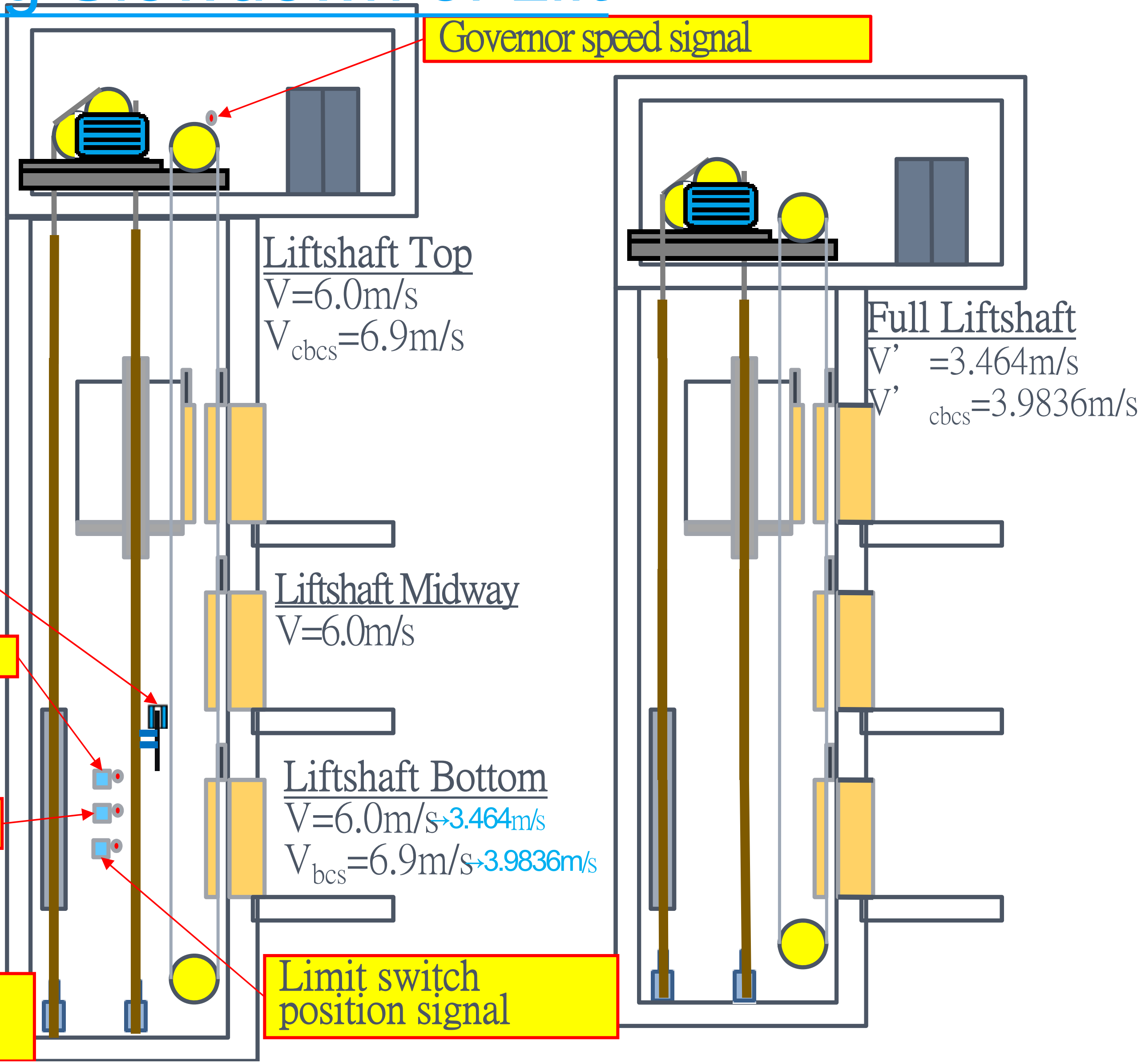
Positive Monitoring Slowdown of Lift

Car buffer stroke (BS) w/o +ve monitoring device
$V=6.0m/s$ (rated speed)
$V_{cbcs}=1.15V=6.9m/s$
(CWT buffer contact speed)
$BS=0.067V^2=2.412m$

+ve monitoring device
1.Governor speed signal
2.Limit switch position signal

Remarks for +ve monitoring
1.A lift behaves as if one with lower rated speed when approaching top landing.
2.If speed > certain value at limit switch, m/c brake applies.

Reduced buffer stroke (RBS) w/+ve monitoring device
V' (equivalent rated speed)<V
$RBS=⅓x0.067x6.0^2=0.804$(>0.54)
RBS=**0.540m** (min value)
$0.804=0.067V'^2$
$V'=\sqrt{(0.804/0.067)}=3.464m/s$
$V'_{bcs}=1.15V'=3.9836m/s$
(Car buffer contact speed)



N.B. Gov signal + Limit switch can assure lift car speed below buffer contact speed.

Safety Measures Controlling Speed of Lift Approaching Terminal Landing

Safety Control Measures for High Speed Lift:

1st Measure: Floor selector (for TWIN, Magnetic absolute length measuring system)
-Magnetic field generator & sensor at car roof (for TWIN, only sensor at car roof)
-Steel vane at car guide rail (for TWIN, magnetic tape on car guide web)

2nd Measure: Terminal stopping switch (for TWIN, barcode positioning system, BPS)
-Terminal stopping switch at car guide rail (BPS)
-Striking cam at car roof (proximity sensor at car roof)

3rd Measure: Final limit switch (for TWIN, barcode positioning system, BPS)
-Final limit safety switch at car guide rail (barcode tape at car guide rail)
-Striking cam at car roof (proximity sensor at car roof)

4th Measure: Positive monitoring control device
-Last limit switch at car guide rail (barcode tape at car guide rail)
-Striking cam at car roof (proximity sensor at car roof)
-Flyball at overspeed governor (tachometer at overspeed governor)

Operation & Maintenance

Operation & Maintenance

1. When one car is switched to any of the following modes, what will happen to the other?
   - Inspection
   - Fireman’ s operation
   - Fire homing
2. When any of following is actuated for one lift, what will happen to the other?
   - Rope slack switch
   - Stop switch
   - Bridging device
3. When one car is broken down or repaired, can the other TWIN maintain normal operation?
4. In case of sequential homing under emergency power, will both TWIN home together or in sequence?
5. If a landing door is opened by unlocking key, can both lift cars maintain their normal operation respectively?
6. Is a passenger aware of which car he is in, upper or lower?
7. Are there any special instructions for building manager and passengers?
8. Can one TWIN be switched off during non-peak hours?
9. Is a passenger aware of which car he is in, upper or lower?
10. Is there any special instructions for building manager and passengers?

Operation & Maintenance

Operation & Maintenance (cont’ d)

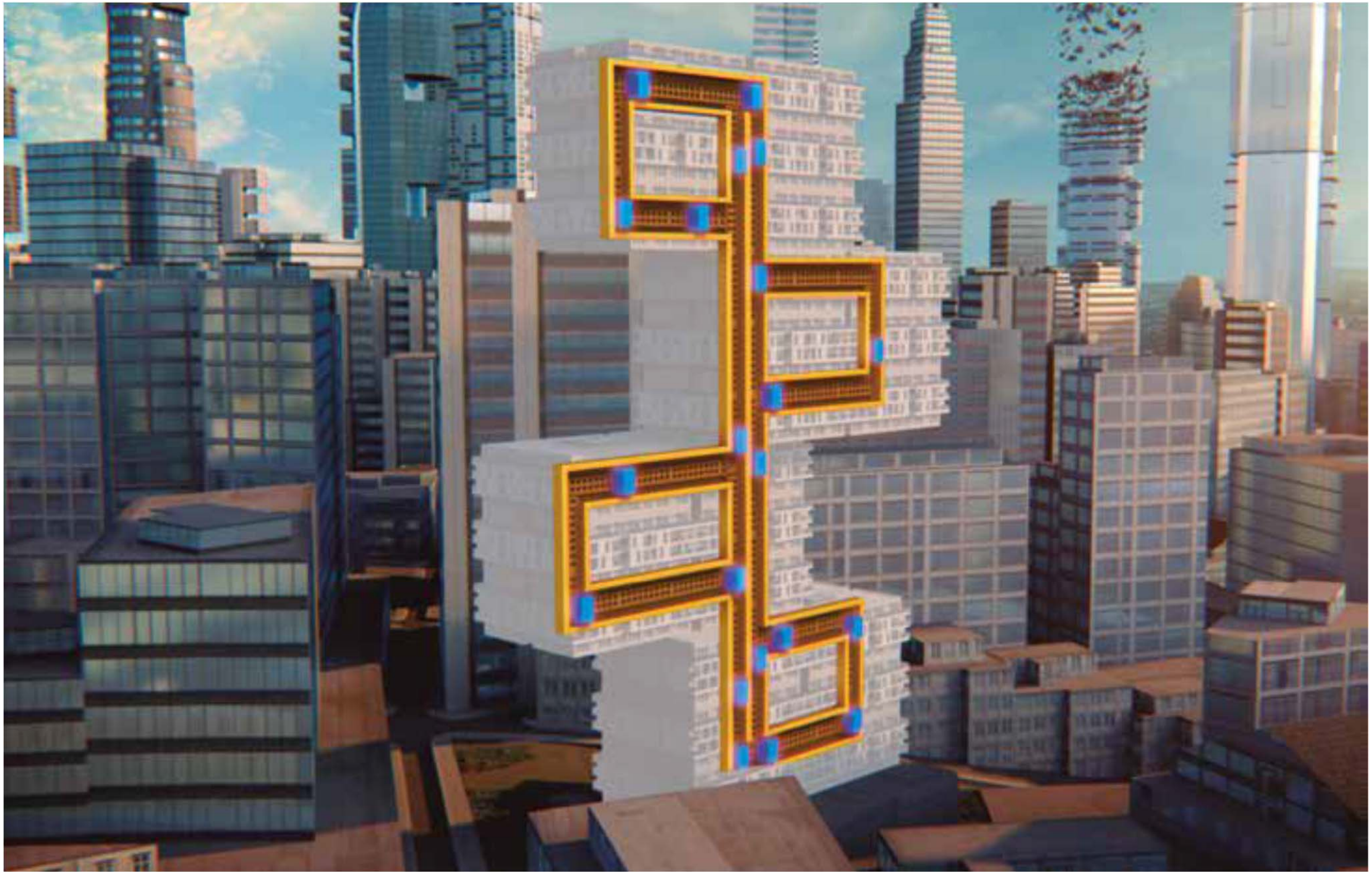
11. Can TWIN be further extended to TRINITY?
12. What will happen if AFA sounds? Will both cars homes to main landings?
12. What will happen if both AFA sounds and normal power also fails?
13. What will happen if main switch of one TWIN is switched off?
14. If one car stops at a certain landing keeps its doors open awaiting an old passenger, will normal operation of another car be affected?
15. Is it safe for upper car to omit its buffer(s)? Can buffers be added to it?
16. If lower car stops at 1/F to facilitate cleaning work inside lift pit, can upper car maintain its normal operation?
17. During routine maintenance, can 2 gangs of workers operate both upper and lower cars respectively under inspection mode? Will CPD function to prevent to prevent collision? Does it solely rely on communication between the gangs?
18. In case of failure of power supply to CPD, should both TWIN’ s maintain their operation? Does it need back-up by means of genset or UPS?
19. When landing door locks are bridged, which car can move at slow-speed?
20. special instructions for building manager and passengers?

Multi

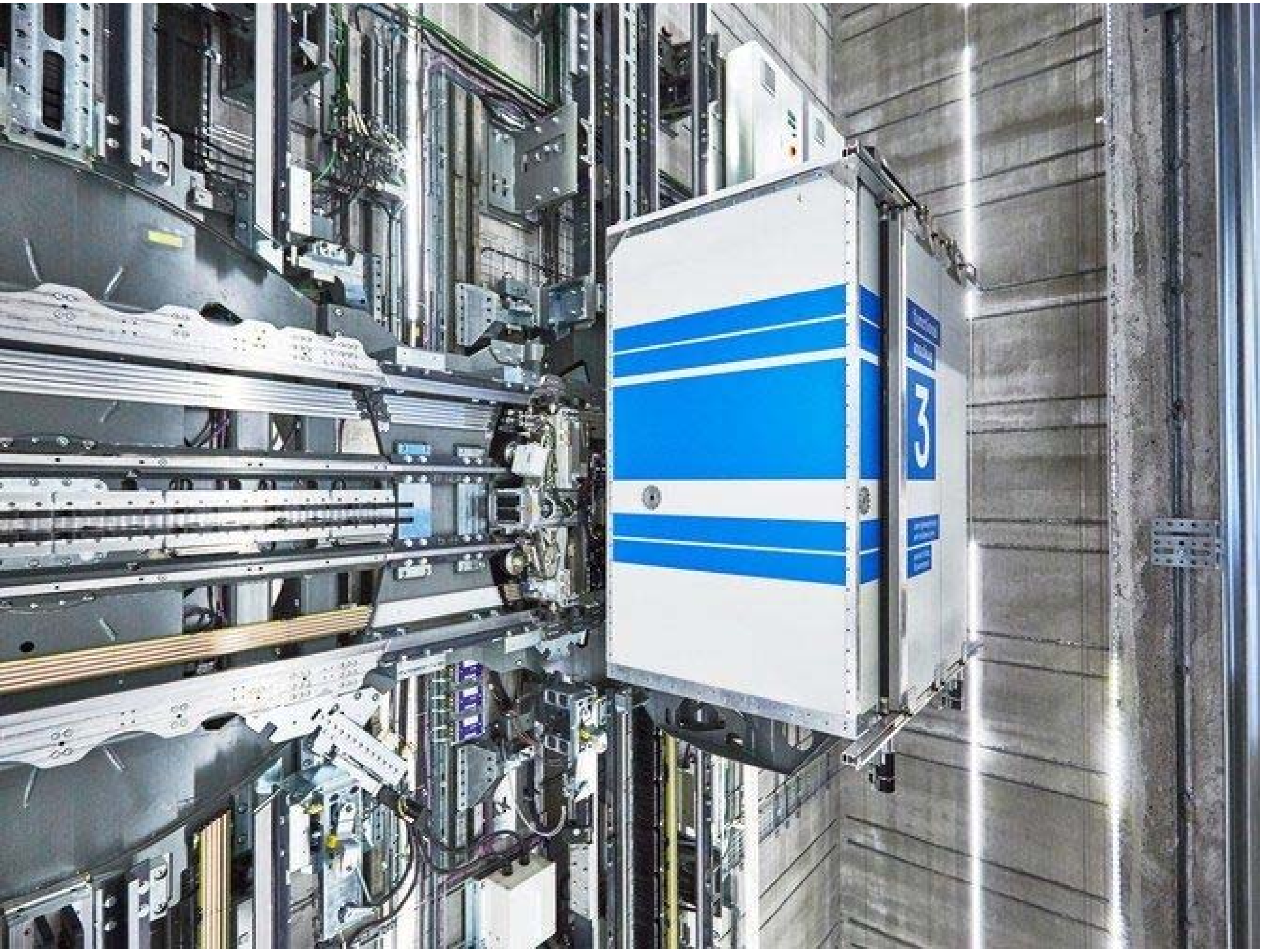
2 Critical Technologies for Multi

1. Linear motor (to eliminate hoist ropes)
2. Horizontal shaft-changing cabin system

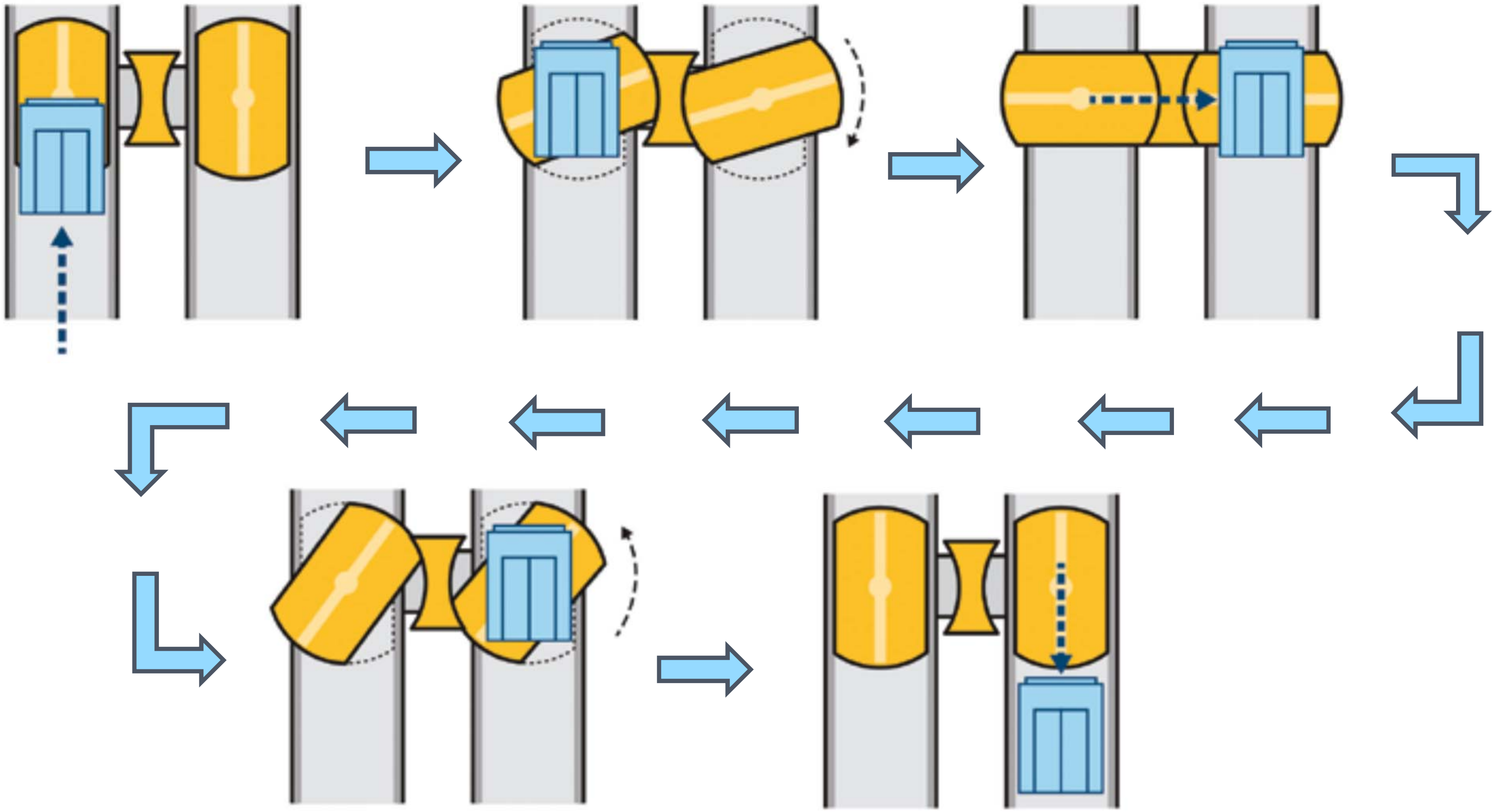
Multi



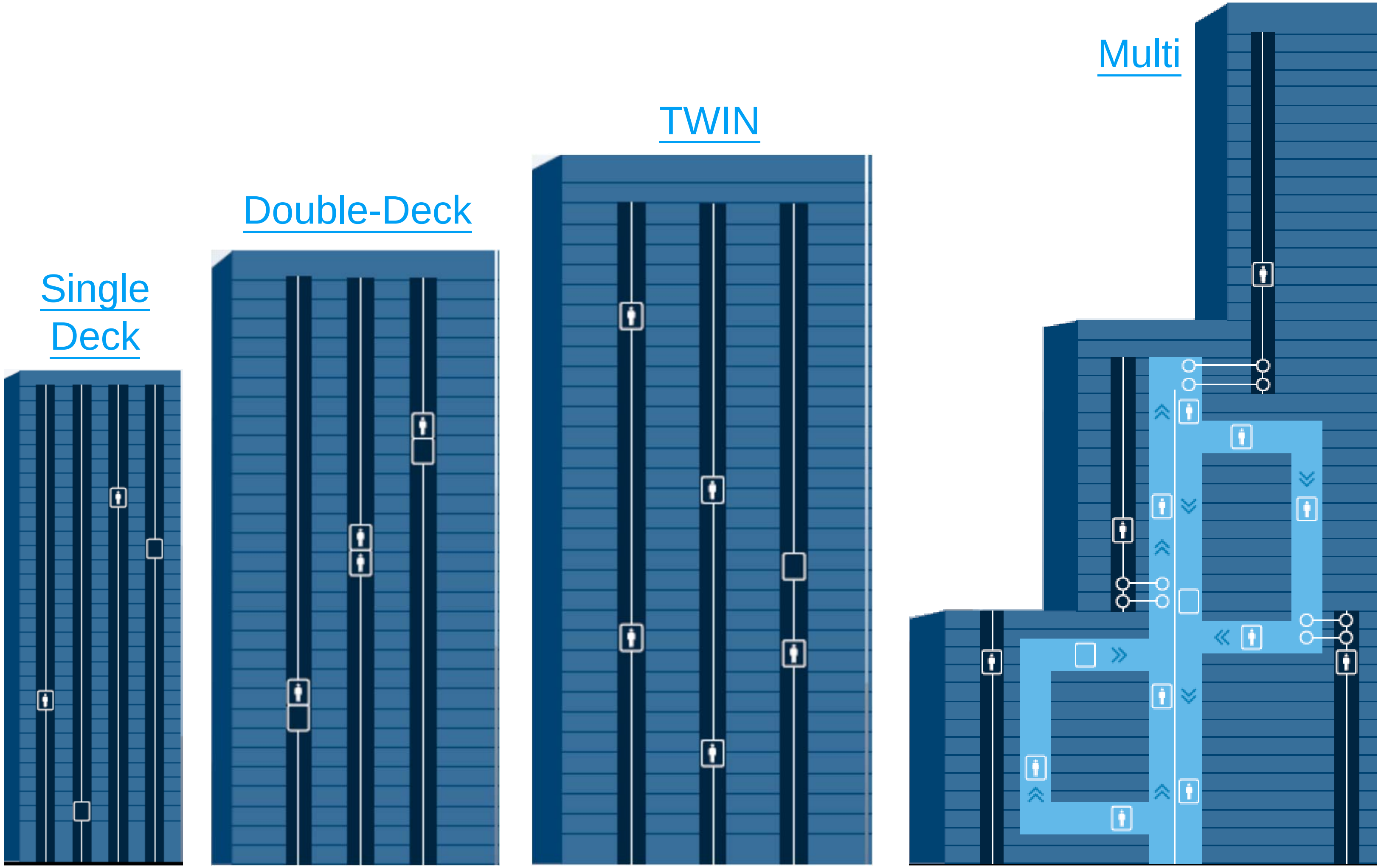
Multi



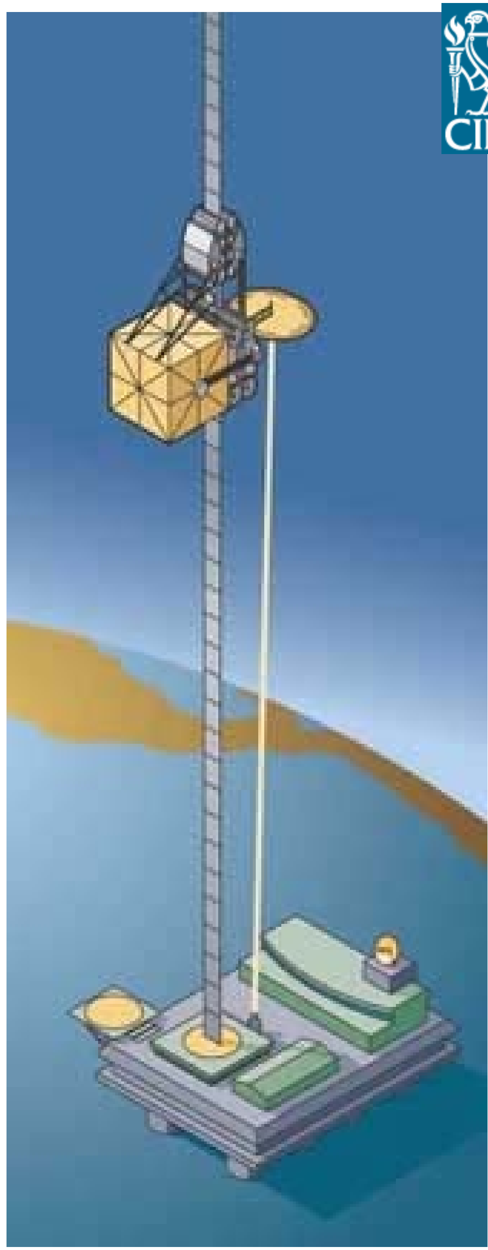
Multi – Horizontal Shaft-Changing Cabin System



Development of Lift in respect of Car Cages

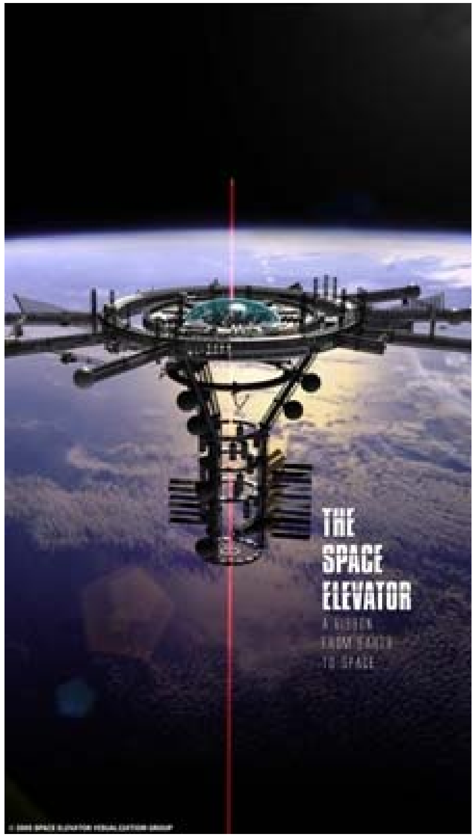


Space Lift



https://www.youtube.com/watch?v=V7N6z7FvF3I (TWIN – Development History 1.55)

Space Lift


THE
SPACE
ELEVATOR


THE
SPACE
ELEVATOR
A RIBBON
FROM EARTH
TO SPACE

Space Lift

- Critical components of space elevator:
  - Cable/Rope at (Railroad, e.g. ¼" carbon nanotube anchored at equator)
  - Counterweight (Space station/centrifugal body in space or above moon)
  - Lift/Elevator Car Cage with Electric Motor (Climber/gondola)
  - Electric motor powering (Photo-voltaic cells + solar/laser beam power)