Elevator Modernization: An Effective Way to Improve the Performance, Efficiency and Safety of Aged Elevators

針對升降機老化：提升其性能、效率和安全性

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Mitsubishi Elevator Hong Kong Co. Ltd.

In Hong Kong,

>20,000 Elevators

being operated for over 20 years

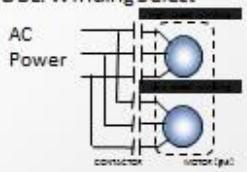
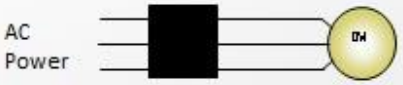
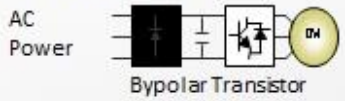
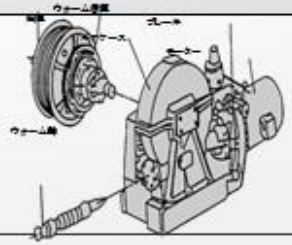
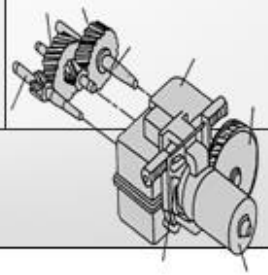
User's Expectation

User's Expectations on Elevators:

- Riding Comfort
- Reliability
- Energy Performance/ Efficiency
- Traffic Handling Capacity
- Nowadays Safety Codes

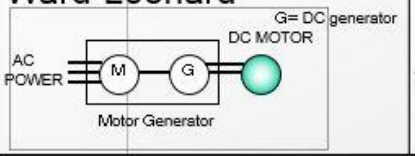
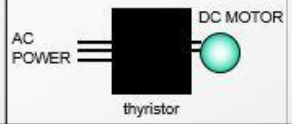
Elevator Technology Development

Low Speed Elevator

Date		1970	1980	1990	2000	2010
Control		Relay 	Micro-Processor 			
Motor Drive		DBL. Winding select 	Primary voltage control 	Invertor Control  		
Power Device		Contactor	Thyristor	Bypolar transistor	IGBT(Insulated Gate Bypolar Transistor)	
Traction Machine	Motor	Induction Motor（IM）				Synchronus Motor（PM） 
	Mechanical Efficiency	Worm Gear 		Helical Gear 		Gearless
Machine Room		With Machine Room				Machine room less

Elevator Technology Development

High Speed Elevator

Year	1970	1980	1990	2000	2010
Control	Relay circuit 		Microprocessor controlled 		
Motor Drive	Ward-Leonard 	Thyristor Leonard 	Inverter (VVVF) 		
Power Device	Motor Generator Set	Thyristor	Bypolar Transistor	IGBT	
Traction Machine — Motor	DC MOTOR		Induction Motor	Synchronus Motor (Permanent Magnet)	
Traction Machine — Mechanical Transmission	gearless 		Helical gear 	Gearless  	

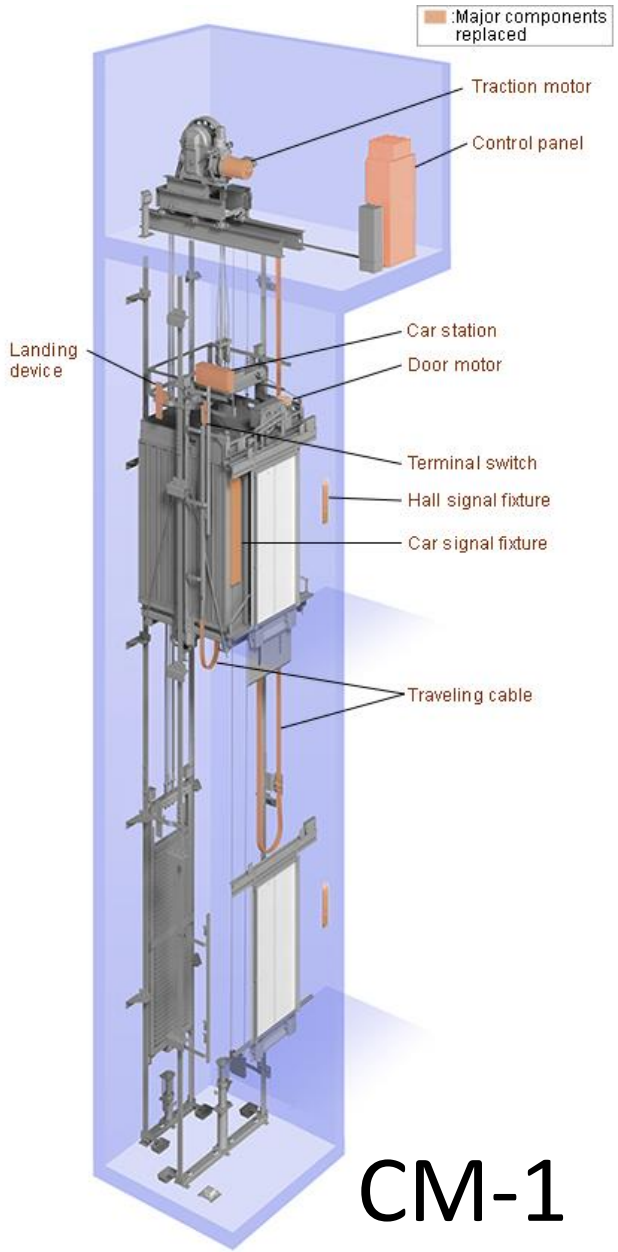
MITSUBISHI ELECTRIC
Changes for the Better

Riding Comfort, Reliability & Energy Efficiency

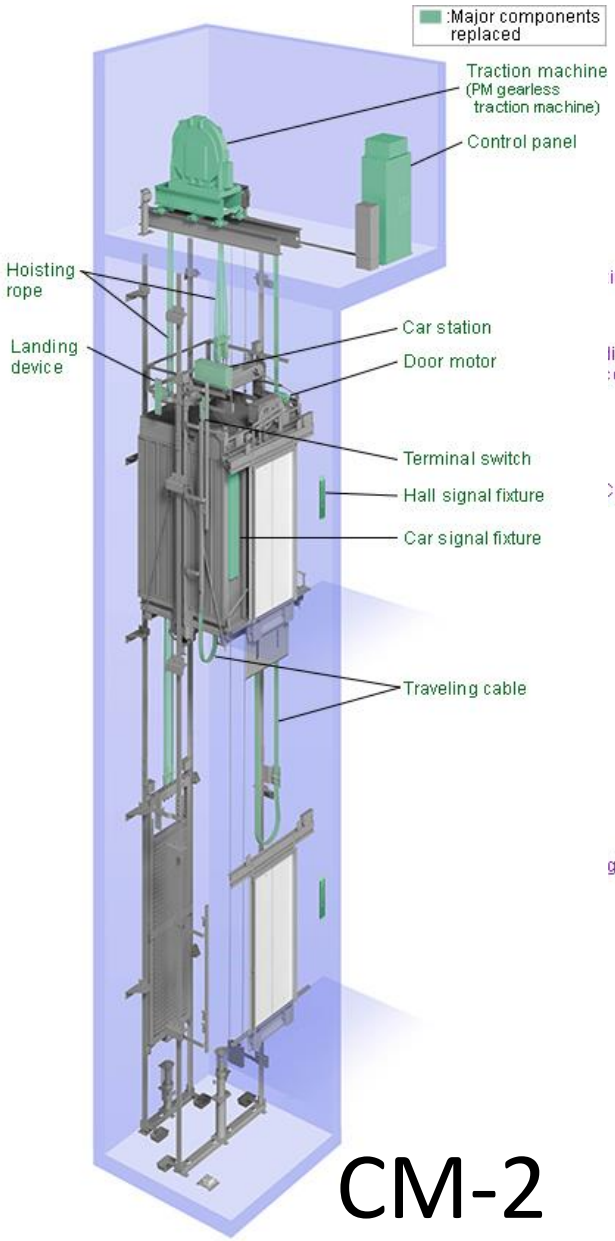
for a greener tomorrow eco Changes

	Riding Comfort		Reliability		Energy Efficiency		Traffic Handling Capacity	
Time	70's Tech.	Current Tech.	70's Tech.	Current Tech.	70's Tech.	Current Tech.	70's Tech.	Current Tech.
Technology	AC-2	VVVF	Relay Type	Computerized Control	AC-2/ ACVV + Worm-gear + Induction Motor	VVVF + PM Gearless Motor	Relay type, non-programmable	Computerized, AI Logic
Characteristics	Discrete and hard	Smooth and seamless	Contact type, breakdown easily	PCB type, static, less breakdown	Induction motor saturate, mech. trans, energy loss	V/f = Constant, gearless, energy efficient	Single logic	Rule-set optimizer, real time simulation
Related Components	**Motor Drive**		**Control Panel**		**Control Panel + Motor Drive + Traction Machine**		**Control Panel**	

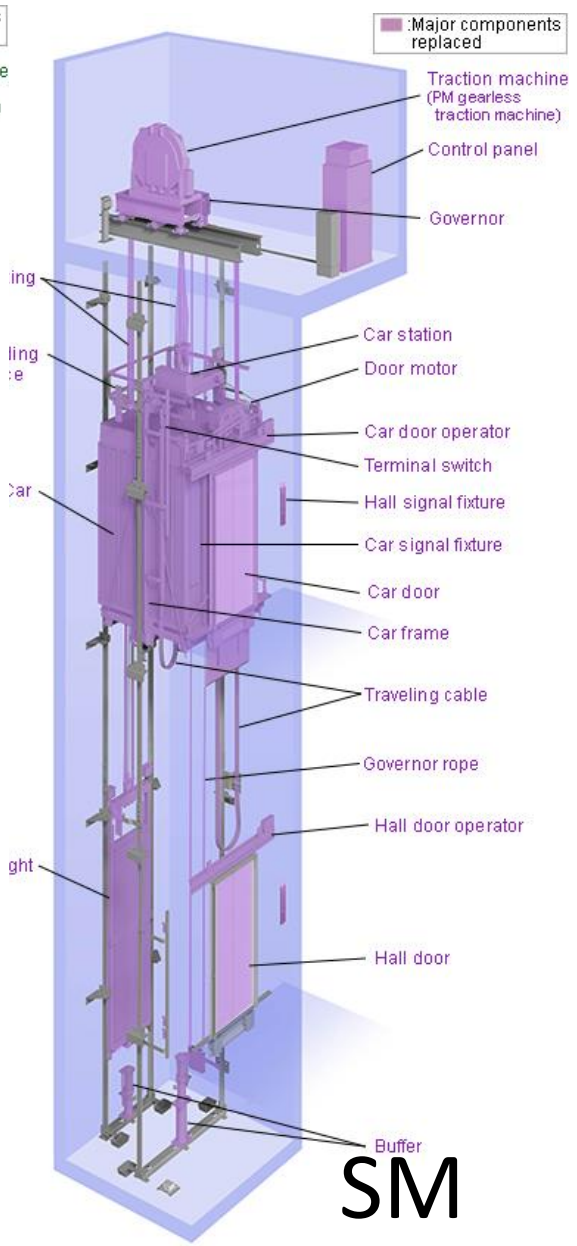
Modernization Scope



CM-1



CM-2

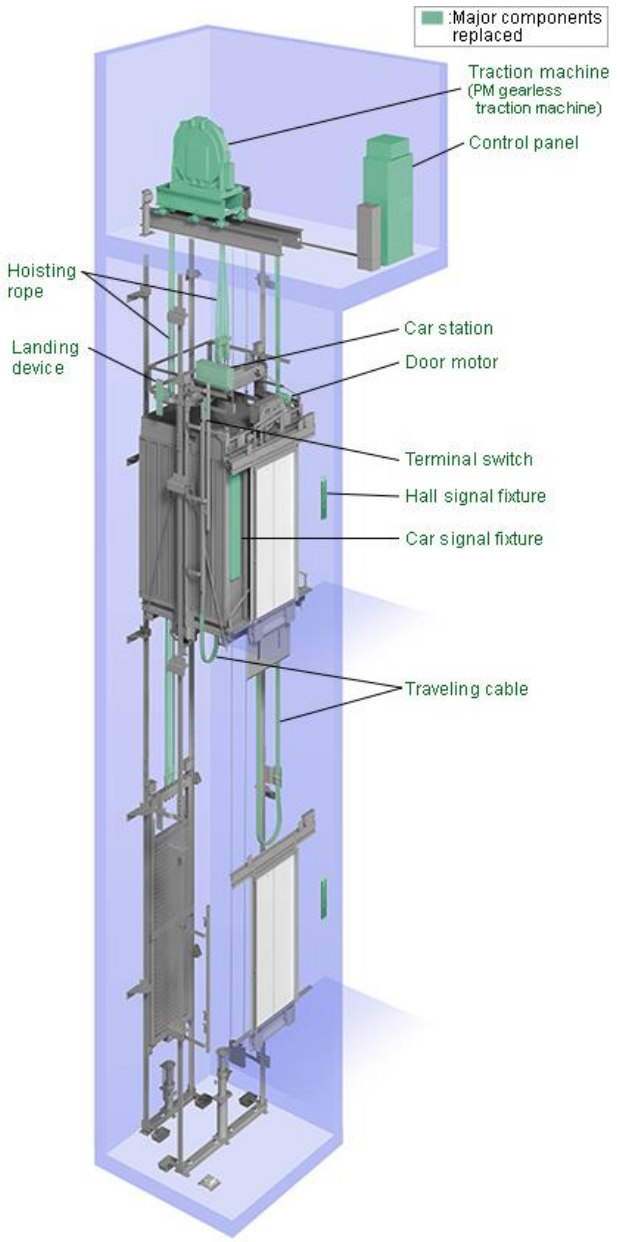


SM

Modernization Scope

CM-2

- Traction machine
- Control panel
- Shaft signalling
- Door motor
- Travelling cable
- Indicators



Modernization Scope

CM-1

- Traction motor
- Control panel
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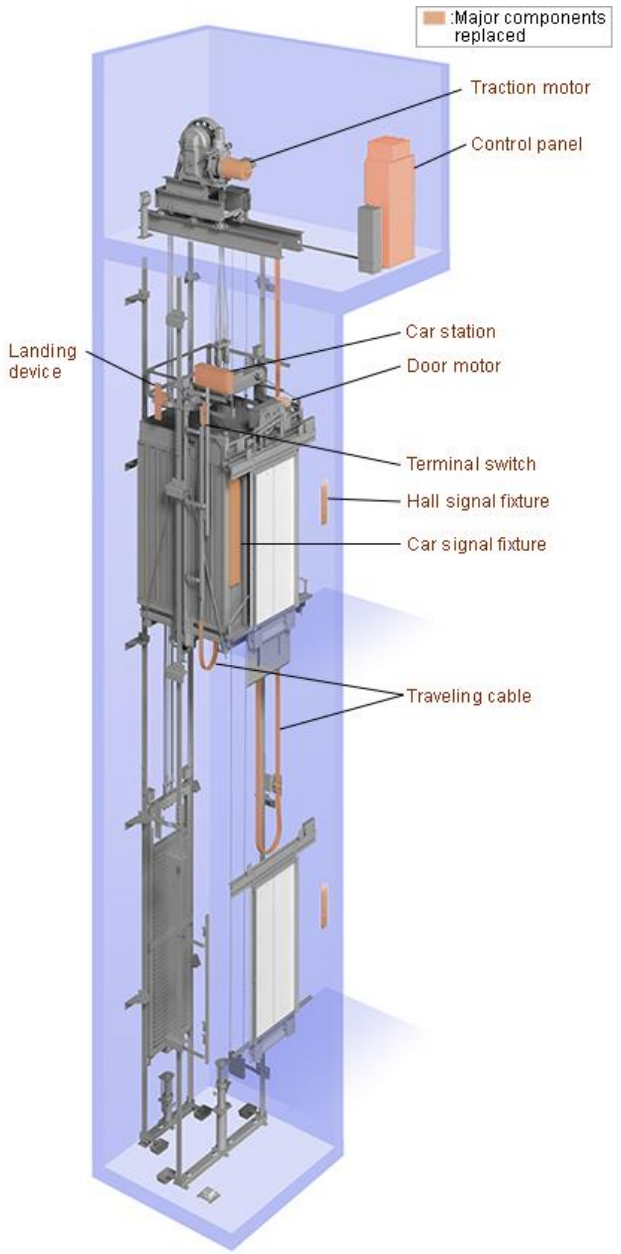
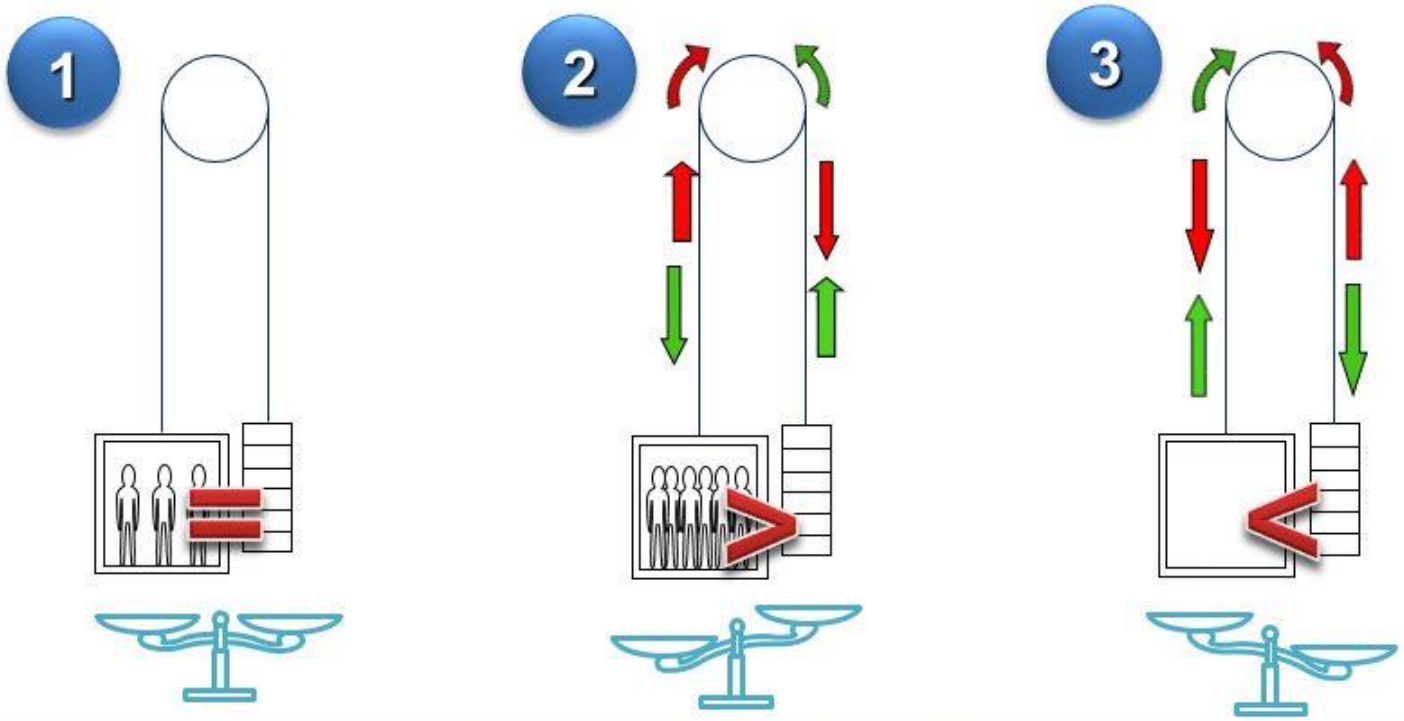


Energy Efficiency

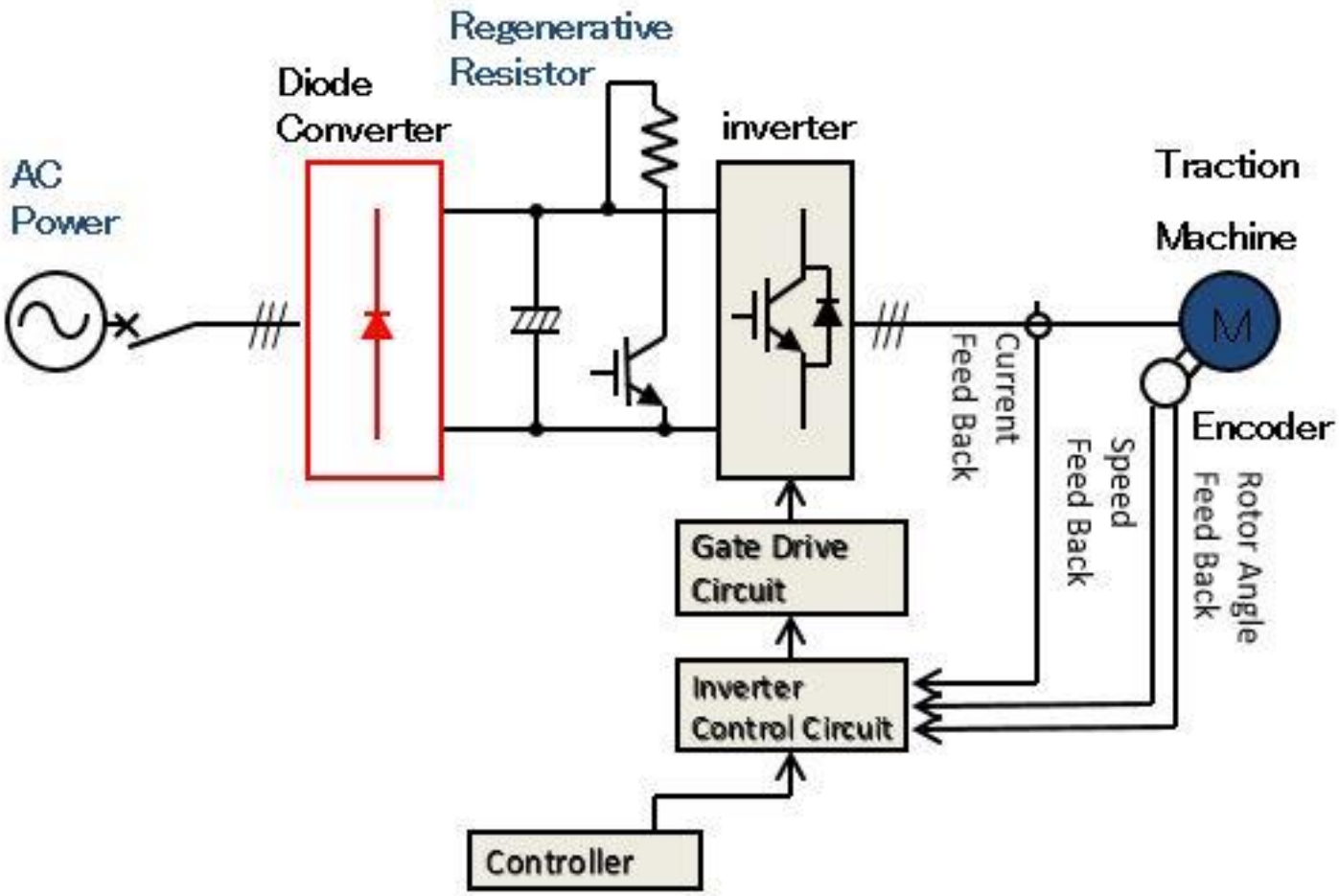
Regenerative Converter



1. Elevator system design： cage weight + 50% rated capacity = weight of counterweight
2. Under full load condition, cage side is heavier than counterweight side, motor is consuming energy when moving up but generating energy when moving down
3. Under no load condition, cage side is lighter than counterweight side, motor is consuming energy when moving down but generating energy when moving up

Energy Efficiency

Regenerative Converter



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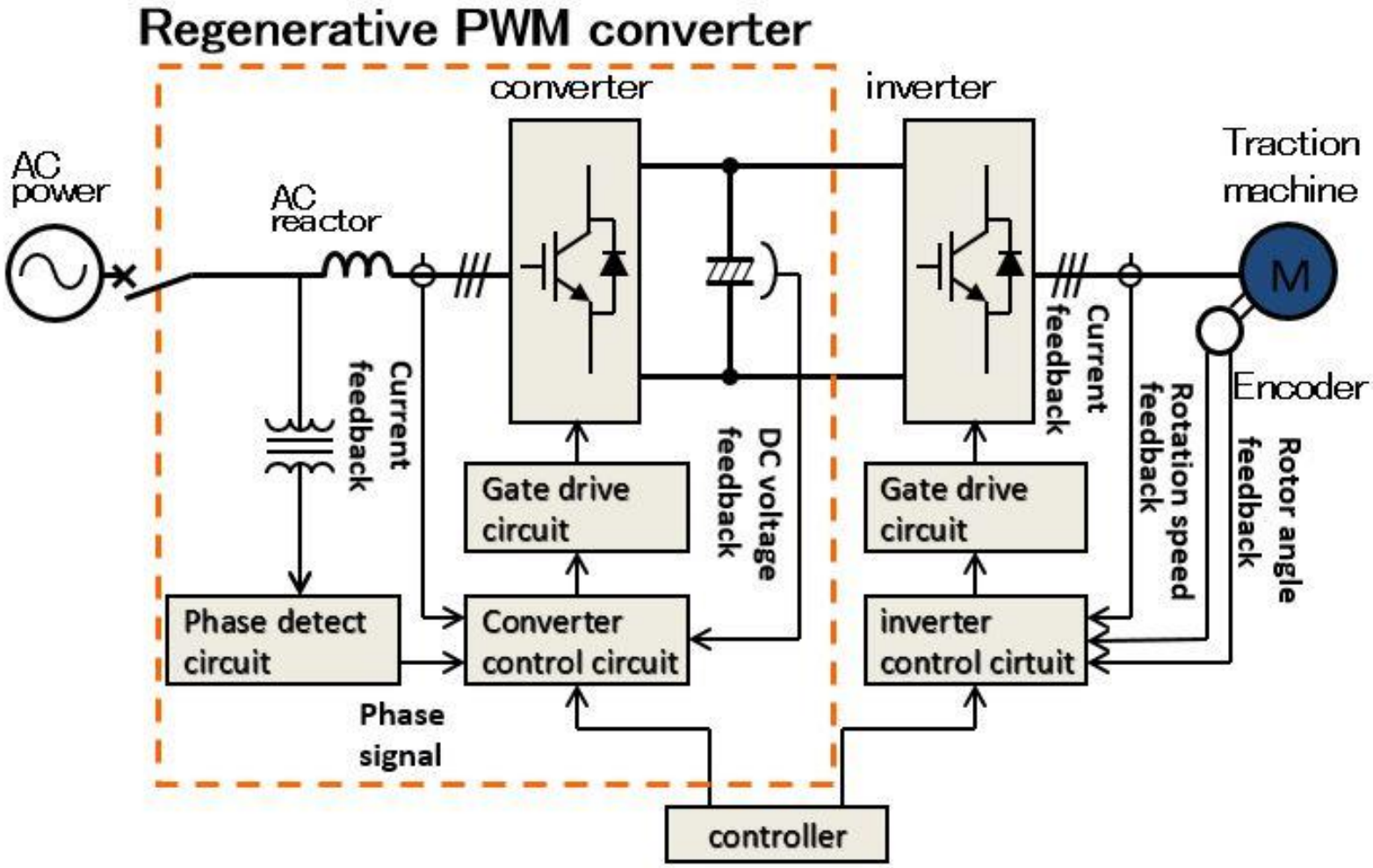


Energy Efficiency

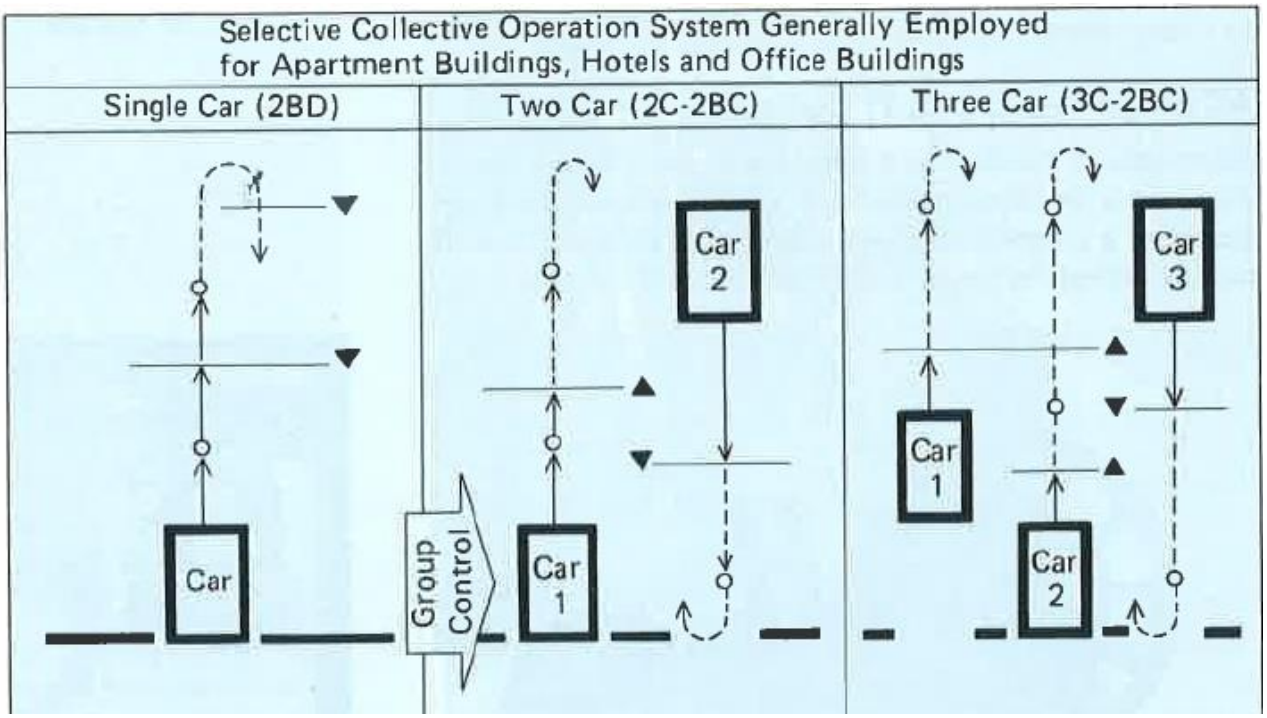
Regenerative Converter

Project	Commercial Building A	Commercial Building B	Residential Building C	Residential Building D
Capacity	1800kg	1600kg	750kg	900kg
Speed	8.0m/s	6.0m/s	3.0m/s	3.5m/s
% Regenerative Energy (24 hrs measurement)	45.8%	43.4%	21.6%	27.7%

Definition of Percentage of Regenerative Energy:
Total energy generated in regeneration mode/ Total energy consumed in motoring mode

Traffic Handling Capacity

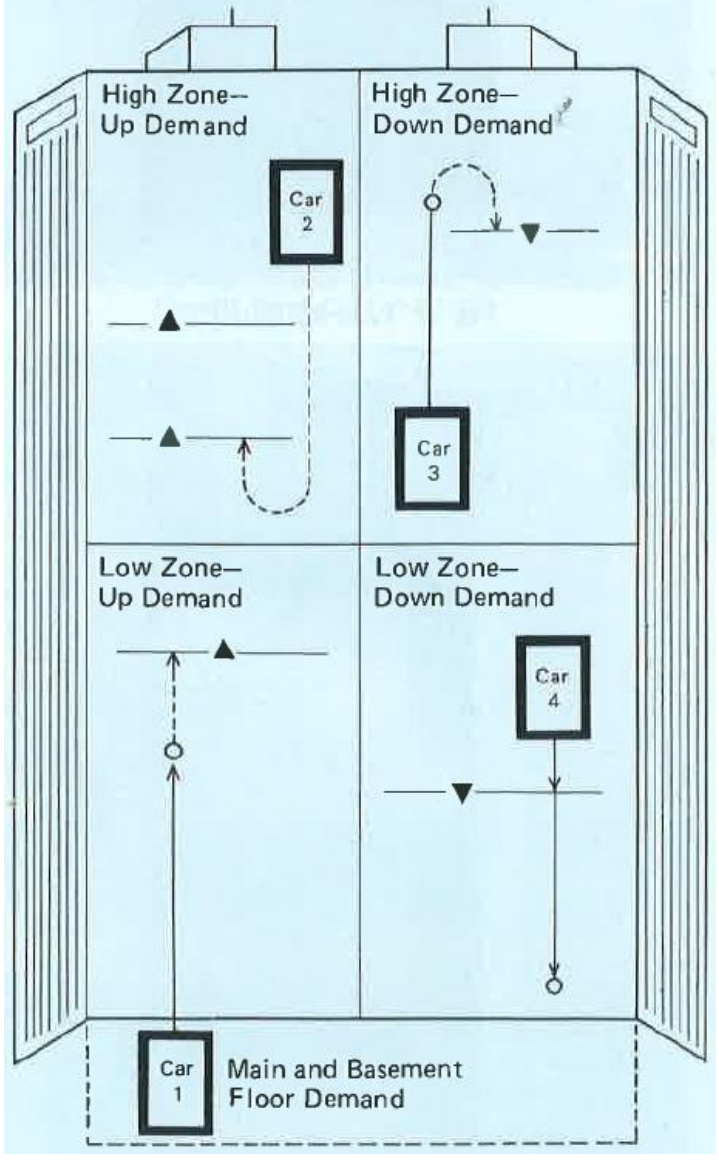
2BC (2 Buttons selective Collective)



- Adopted in 1970's
- Highest Call Reversal
- Lowest Call Reversal

Traffic Handling Capacity

OS-75 (Optimum Service)



- Adopted in 1980's

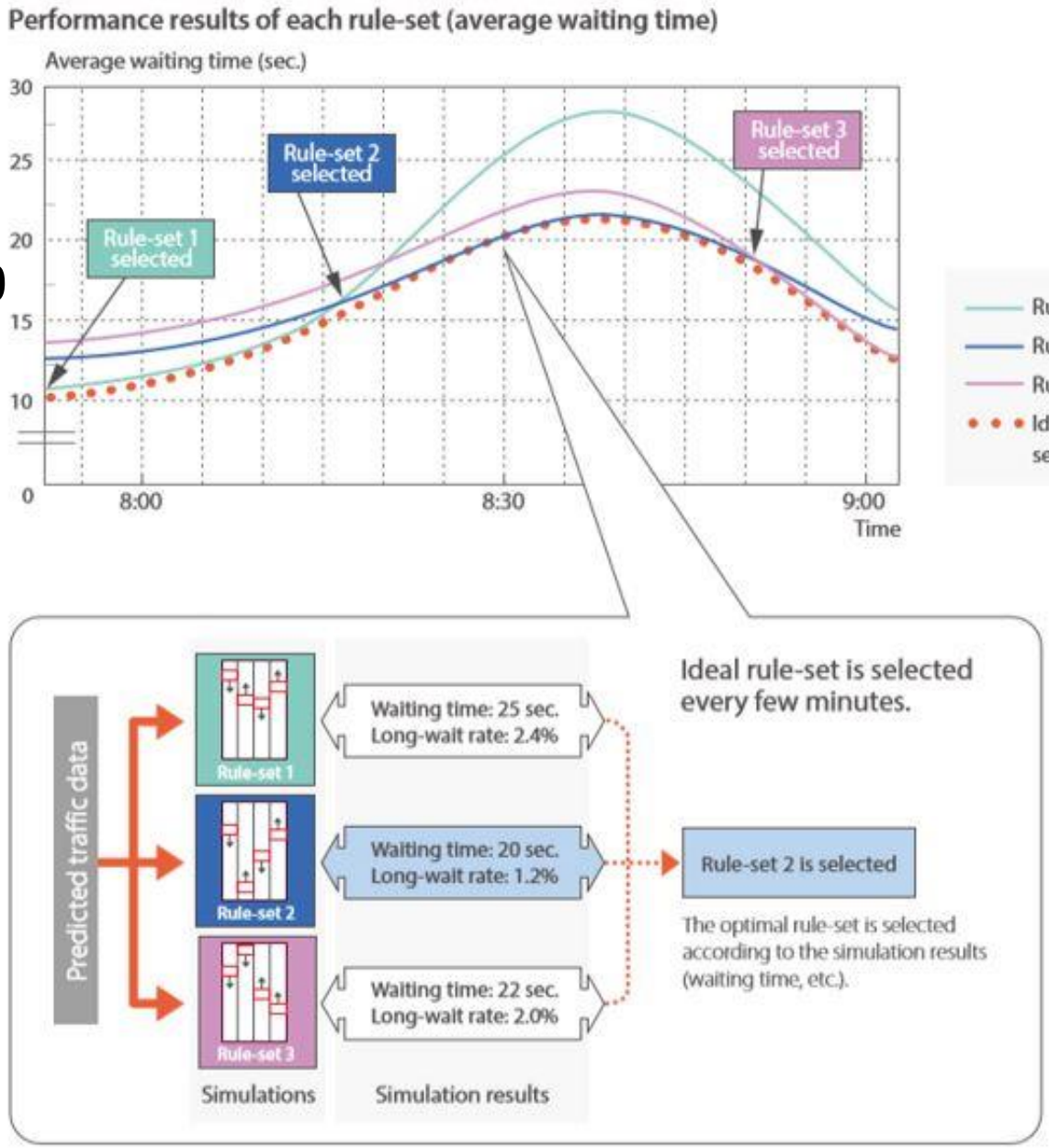
- Demand Zones (in priority)
  - Main floor up demand
  - High zone down demand
  - Low zone up demand
  - Low zone down demand
  - High zone up demand

- Dynamic assignment of zones

Traffic Handling Capacity

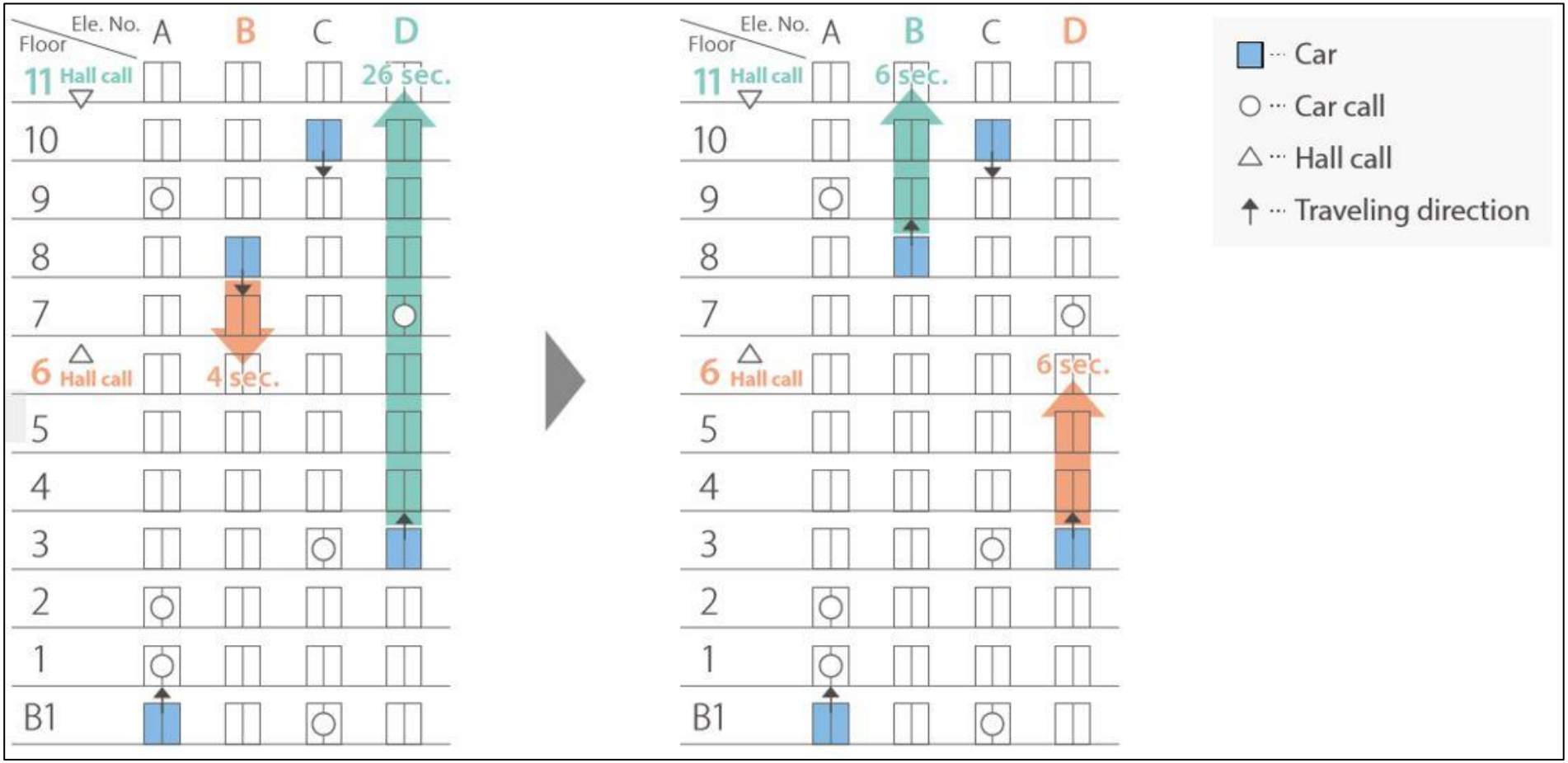
∑AI-2200C

- Adopted in late 1990's and after 2000
- Traffic demand predication
- Rule-set simulator



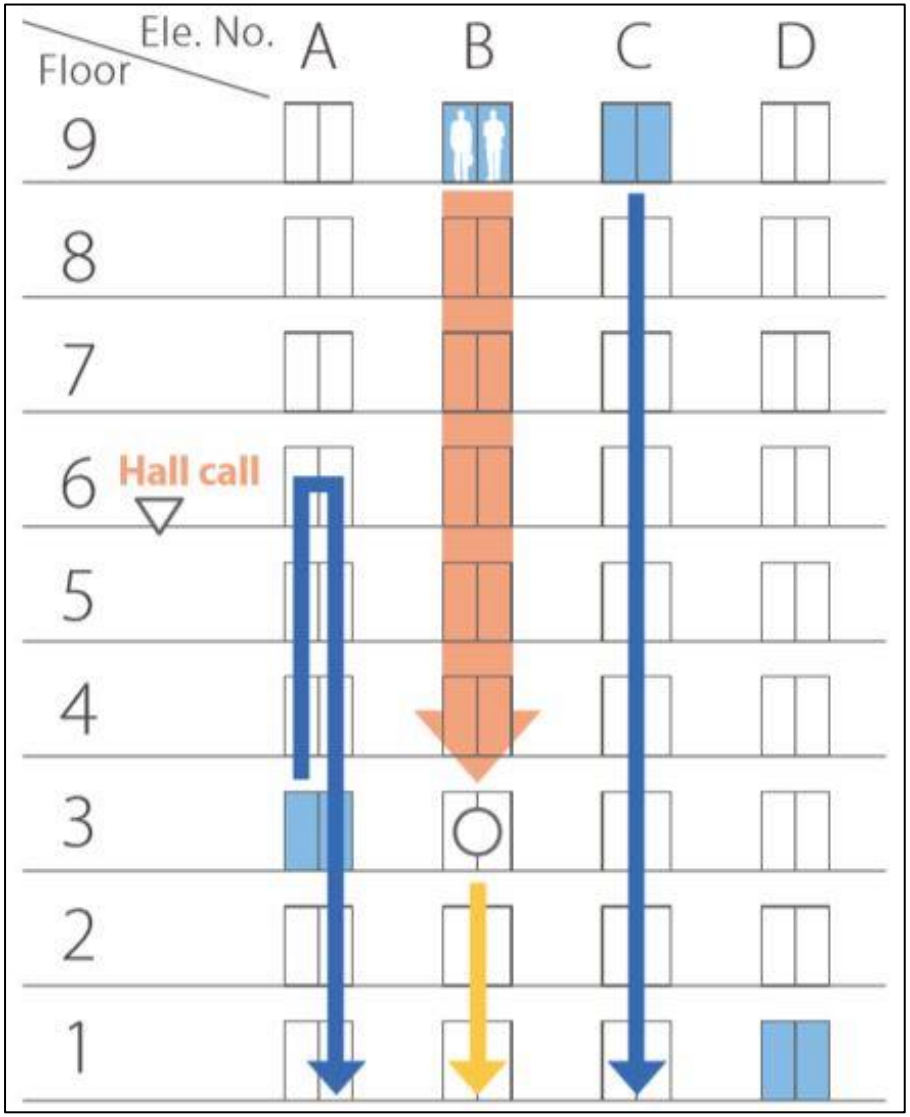
Traffic Handling Capacity

Cooperative Optimization Assignment



Traffic Handling Capacity

Energy Saving – Allocation Control

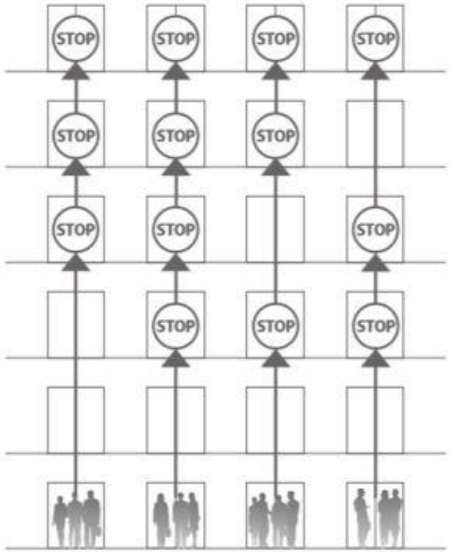


Traffic Handling Capacity

Destination Oriented Allocation System (DOAS)

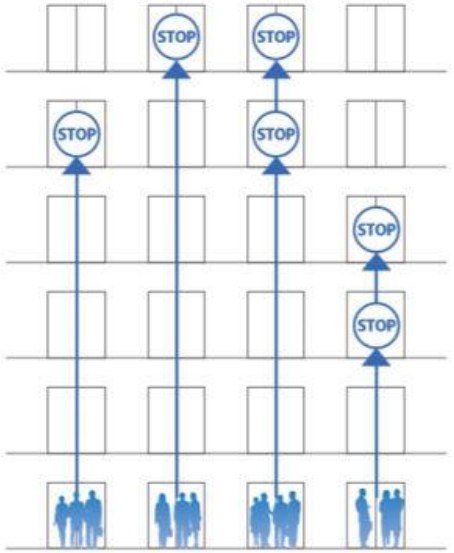
Without DOAS

Cars make stops at every selected floor because destination floor is not considered for car allocation .

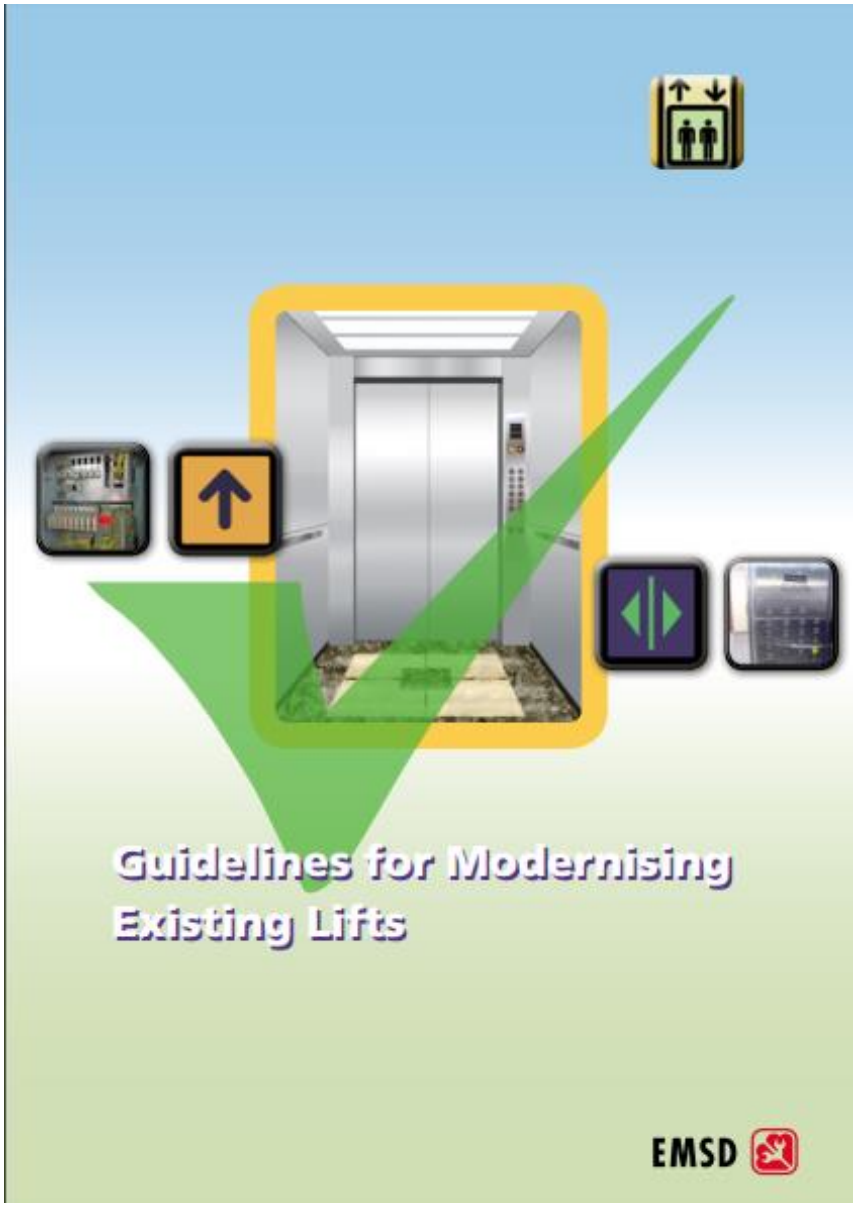


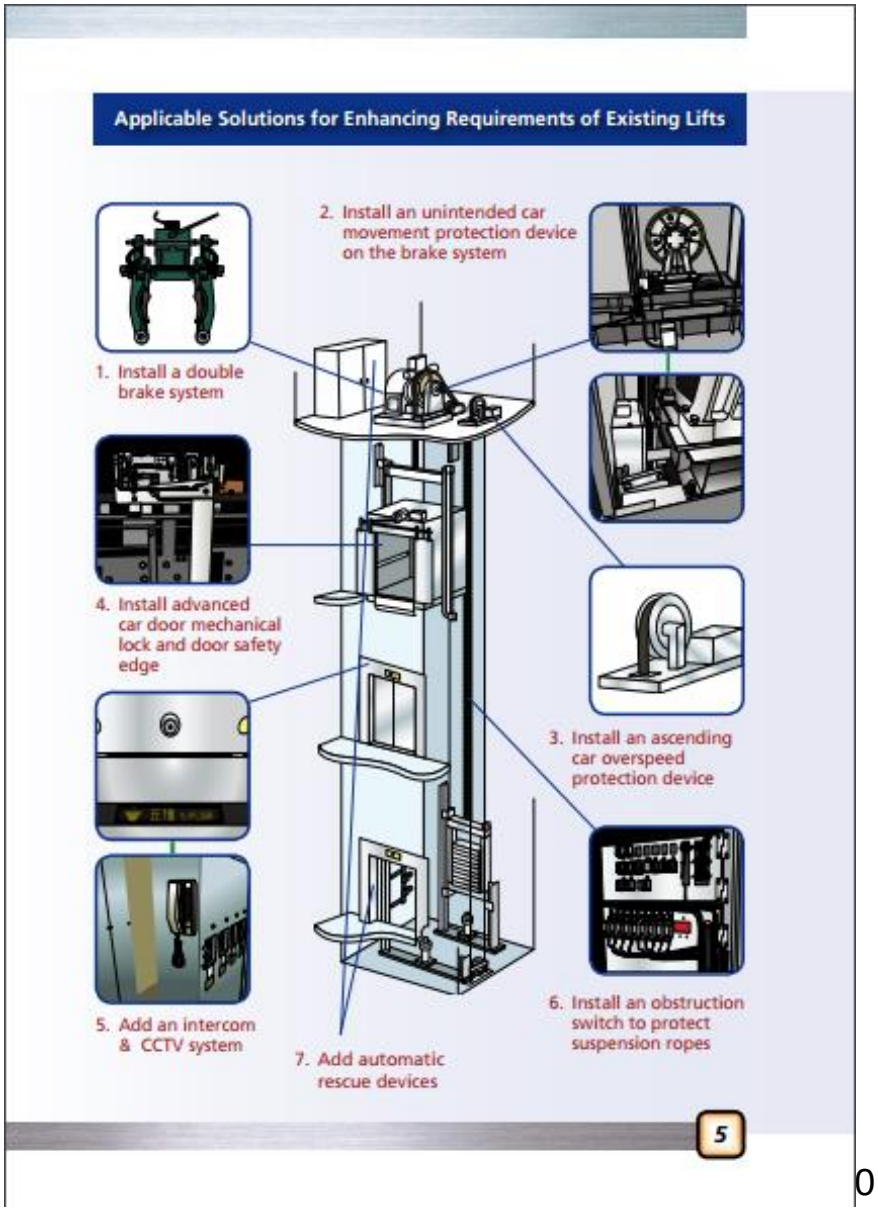
With DOAS

The individualized car allocation based on the destination floors leads to shorter travel time and fewer intermediate stops.



Safety Codes





Safety Codes

Frequency	Severity			
	I	II	III	IV
	Number of Hazardous Situation			
A				
B			30	
C		6, 25, 30, 60	37, 46, 57	
C-D	70	3, 9, 15, 17, 19, 22, 23, 27, 40, 50, 56, 71	29, 45	
D	1, 3, 7, 8, 12, 13, 14, 16, 17, 26, 27, 31, 32, 33, 34, 39, 40, 43, 50, 53, 6  	18, 21, 24, 41, 44, 47, 48, 52, 63, 65 	28, 42, 49, 61, 64 	
D-E	35, 36, 51, 52, 68, 72, 74	20, 38, 55, 67, 69, 73		
E	10, 11, 24, 55, 73			
F				

Severity:
I: Catastrophic
II: Critical
III: Marginal
IV: Negligible

Frequency:
A: Frequent
B: Probable
C: Occasional
D: Remote
E: Improbable
F: Impossible

Priority

- Extreme
- High
- Medium
- Low

Conclusion


Efficient
Reliable
User Friendly
Comfortable
Safe
Energy Saving
Quiet Operation

Thank you