

INSTITUTION OF MECHANICAL ENGINEERS HONG KONG BRANCH  
EVENING LECTURE “ENGINEERING MATCH IN 70s” ON 15/8/2017



*The evening lecture was held in The Hong Kong Polytechnic University on 15/8/2017*

Hong Kong comprises of Hong Kong Island, Kowloon Peninsula (Kowloon) and the New Territories. Municipal public bus services are operated by private companies under the stringent regulation of the government by means of route franchising. By geography, China Motor Bus Co., Ltd. (CMB) was granted a franchise in 1933 to operate franchised public bus (FPB) services exclusively on Hong Kong Island, and Kowloon Motor Bus (1933) Co., Ltd. (KMB) in Kowloon and the New Territories. In 1998, CMB's franchise was taken over by other companies. Above all, to date FPB services shoulder the colossal demand of public transport on roads in Hong Kong.

While the vast majority of the current FPB are double deck models, tracing over half a century back, the FPB operating on Hong Kong Island were once entirely single deck. Subsequently, the public transport demand, particularly in the suburban hilly areas, was subject to an exponential growth in the 1970s, forcing the exclusive FPB service operator on Hong Kong Island, CMB, to take immediate action to respond by introducing larger capacity double deck buses to these areas. The acquisition of readily available double deck buses for use was however beyond reach due to shortage of supply of the suitable models for the local operating conditions. In order to meet the imminent needs of expanding passenger carrying capacity, CMB embarked on a drastic and unprecedented venture in engineering, which was to convert all suitable single deck vehicles in its fleet to double deck.

### **The Chosen One**

Since the grant of its franchise in 1933, CMB had operated an entire single deck fleet of FPB until late 1960s, and after World War II, CMB expanded its fleet with single deck vehicles principally ordered from Guy Motors Limited in Wolverhampton in the U.K. (Guy). The predominant model, Arab Mark IV chassis (Mark IV), featured with Gardner 5LW engine, pre-selector gearbox, 12-volt electrical configuration and servo brakes with cylinders.

Subsequent to Mark IV, Guy launched the succeeding model in early 1960s, the Arab Mark V chassis (Mark V), with higher specifications incorporating more advanced technologies than its predecessor as tabled below:-

Equipment		Mark IV	Mark V
Engine	Model	Gardner 5LW	Gardner 6LX
	Output Power	95 b.h.p. / 70.8 kW	135 b.h.p. / 100.7 kW
Electrical Configuration		12 V	24 V
Gearbox		pre-selector	electro-pneumatic semi-automatic
Brakes		servo brakes with cylinders	air pressure brakes
Wheelbase		14'-6" / 4,420 mm	15' / 4,572 mm
Overall Length		25' / 7,620 mm	25'-1" / 7,645 mm
Overall Width		7'-6" / 2,286 mm	8' / 2,438 mm
Laden Frame Height		2' / 609.6 mm	1'-91/2" / 546.1 mm
Seating Capacity		30 seats	30 seats
Standing Capacity		14 standees	18 standees

In 1963, CMB initially purchased 106 units of Mark V chassis with 4,572 mm wheelbase and locally assembled single deck bodies on them with completely knock-down (CKD) body kits supplied by Metal Sections in the U.K. (Metsec). Subsequently, it acquired 40 units of Mark V chassis in 35'-7" / 10,845.8 mm overall length and with 22' / 6,705.6 mm wheelbase, also fitted with Metsec single deck bodies which were assembled locally from CKD body kits. Notwithstanding being endowed with double deck technical capability, as exemplified by their cousins back home, the Mark V chassis had served in the CMB fleet, both in wheelbases of 4,572 mm (short wheelbase) and 6,705.6 mm ("Long Dragon"), as single deck buses until the time of calling for their double deck potential came. During this period, some 115 Guy Mark V chassis fitted with 30'9,144 mm Metsec bodies later classified as "LW" were also purchased to operate a few flat routes in the urban area.

### **Demand Surges**

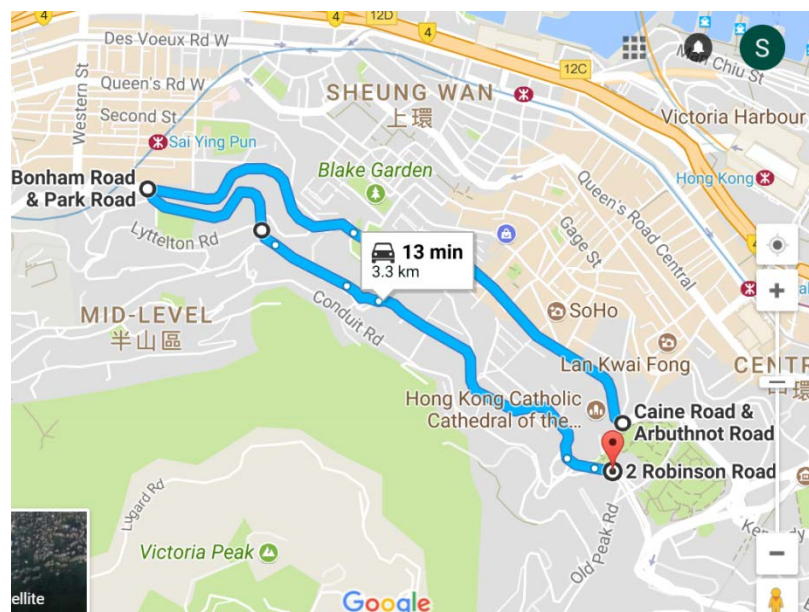
The roads on Hong Kong Island, which were exclusively served by CMB-operated FPB, featured tight bends, steep gradients, constraints in road width and height restrictions such as low bridge and unprecedented surge in demand. A few infrastructural factors attributed to the increase in public transport patronage.

*New public housing estates:* The government of Hong Kong expanded the provision of welfare housing to the population in the form of Public Housing (Council Housing in the U.K. terms) Estates. Within seven (7) years between 1969 and 1976, Wah Fu Estate (1969), Chai Wan Estate Phase 2 and Wong Chuk Hang Estate (1970) and Lai

Tak Tsuen (1976) commenced occupancy, yielding a surge in the residential population on Hong Kong Island and the associated demands on public transport.

*Cross Harbour Tunnel:* Hong Kong Island and Kowloon is separated by the famous Victoria Harbour. Historically the only means of connecting two places was by ferry, both passenger and vehicular. However, the means of crossing the harbour was tremendously enhanced by the first Cross Harbour Tunnel which came into service in 1972, linking the two areas by road for the first time. Very soon, people realised the convenience of crossing the harbour by road, and the newly generated FPB patronage between Hong Kong Island and Kowloon outstripped the capacity which the FPB operators could offer with the jointly operated cross harbour services.

*Mid-Levels bus lane:* Hong Kong Island is a hilly island in itself and a substantial portion of the population, especially the affluent car owners, reside in the apartment blocks along the narrow roads built on the slopes along the southern coast of Victoria Harbour. As the city developed in the 1960s and 1970s, this particular part of Hong Kong Island, which is generalised as Mid-Levels, accommodated more residents and the traffic became heavier and exceeded the road capacity. To redress the traffic congestion at Mid-Levels, the government drastically introduced a bus lane scheme in 1974, which permitted only FPB to access the designated traffic lanes. Considering the initial fierce opposition due to the inconvenience brought to the private car users, the scheme was optimised to be in a loop form in the two-tier road terrain in the hilly area, whereby one (1) lane of the two (2) way roads in Mid-Levels was changed to a bus only loop in the anti-clockwise loop whilst the all vehicles lane opposite remains in the clockwise loop in the daytime hours. In response, the demand of public bus services at Mid-Levels rose sharply, which CMB had to meet with the deployment of double deck buses for delivering sufficient passenger carrying capacity. While the Mid-Levels public bus services had been exclusively single deck in the early years, more double deck buses marched into Mid-Levels with the introduction of the bus lane scheme.



A prerequisite of the government for allowing double deck buses to advance uphill to serve Mid-Levels was the deployment by CMB of a recovery vehicle with sufficient

power at the major bus terminus by Victoria Harbour, Central Terminus, ready to recover any malfunctioned double deck bus at Mid-Levels at any time. At that time, the existing recovery vehicles were Mark IV-converts with pre-selector gearboxes which were inadequate and difficult to perform towing from start on slopes. A more powerful model was required, and while CMB intended to have the candidate vehicle to be converted from one in the existing fleet, one (1) of the aforesaid 106 single deck 4,572 mm wheelbase Mark V bus with vehicle number plate AD4563 was eyed upon. As a result, after about nine (9) years of passenger service, it was converted into a tow truck and stationed at Central Terminus for most of its service life, until it was disposed of in 2007. AD4563 was subsequently saved from the scrapyards and has taken ten years to be restored to its 1963 glory, and the restoration process was shared in IMechE Hong Kong Branch evening lecture titled “Public Vintage” on 13/3/2017.

For more effective vehicle recovery at that time, CMB acquired a purpose-built recovery truck based on a Volvo N10 chassis in 1977. Endowed with an EKA “SuperCompact” recovery system from the U.K, it was the first vehicle in Hong Kong with the capability of towing a double deck bus with long front overhang by lifting its front axle with its rear extendible hydraulic jib. This has become standard practice in the recovery of heavy commercial vehicles.

*Nam Fung Road:* Although the developed areas of Hong Kong Island have been concentrated on the strip along Victoria Harbour at the north, the southern coast sees a sized community named Aberdeen (“Little Hong Kong” in Chinese literal meaning), where the above-mentioned Wong Chuk Hang Estate is located. No direct bus service between the northern and the southern parts was available because the most direct connecting road was too narrow for buses. In 1973, the government commissioned a short-cut avenue, Nam Fung Road, which drastically cut travel distance and time and improved the convenience of commuting between the northern and the southern parts of Hong Kong Island. In result, people were incentivised to travel between the two parts of Hong Kong Island, generating demand for transport. *(Please refer to the Appendix for more details about the significance of Nam Fung Road.)*

*Ocean Park:* Located at Wong Chuk Hang in the south of Hong Kong Island, Ocean Park, an aquarium cum aquatic theme park, was opened in 1977. It was the first theme park in the territory and well-received by both foreign visitors and local residents, generating a significant demand on public transport for the access to it.

Institutional factors also contributed to the change in people’s inhabitation pattern and stimulated the demand of public transport.

*Weekly rest day:* Unlike nowadays, in the past Hong Kong had no concept of rest day and people, mainly factory workers, laboured all days in a week in order to qualify for a full attendance bonus. The government established the statutory rest day ordinance in 1970, mandating all employers to grant employees one (1) day of rest in any complete work week, predominately on Sunday. People were compelled to be off from work one (1) day every week, facilitating them to take rest and travel for leisure and swimming at beaches.

*Statutory holidays:* The government introduced statutory festival holidays in 1973 in addition to the statutory weekly rest days. Initially ten (10) festival days in a year



were assigned statutory holidays, and the statutory holiday list expanded in time. The government further stimulated people to go for picnics and leisure travel in 1976 by setting up country parks in the suburban area, boosting the public transport demand on holidays.

*Annual leave:* The Annual Leave ordinance came into force in 1977, entitling every employee seven (7) minimum days of paid leave in a year. This further encouraged people to go on outings and hence added the pressure on public transport services on Sundays and public holidays.

All the above infrastructural and institutional factors resulted in surges of transport needs within the city at all times and on the countryside bus routes to attractions and natural sceneries. The (countryside) suburban routes were in the early years consistently in low demand for the scant populates and adequately served with single deck buses at very low frequencies. After these factors came into play, however, the queues for buses to and from the beaches and countryside were endlessly long on weekends and holidays and the single deck buses were far from adequate to meet the pressing demand. Although double deck buses came into the CMB fleet in large scale as early as 1963 and their number increased in time, the long delivery lead time of new buses on order CMB was inadequate to meet the demand for CMB. An immediate expansion of capacity was imperative, pending CMB to respond in an unprecedented way.

### **Go Double**

As described, the Mark V chassis in the CMB fleet were double deck-capable though initially fitted with single deck bodies to suit the vehicle type allowable for operation in the earlier days. The latent power of the short wheelbase Mark V units was undesirably revealed in a series of traffic accidents.

Connecting Aberdeen and the west end of the developed strip of Hong Kong Island, Western District, was a two (2) lane, dual direction avenue named Pok Fu Lam Road which featured long slopes and narrow lanes. The abovementioned Wah Fu Estate is located off Pok Fu Lam Road at the western edge of Aberdeen. Scheduled FPB service was provided by the short wheelbase Mark V single deck buses of CMB. At the same time, a large number of private “dual purpose” (for passenger and goods) light trucks, predominately Leyland FGs, originally plied along the route for carrying the farmers in the double cab and their produce in the rear open cargo compartment to the a government vegetable wholesale market in Western District, and covered the shorter leg of the trunk bus route. These paratransit lorries gradually developed into the pioneer of the later minibuses by carrying commuting passengers only but at variable fares according to demand. In competition with the, these light trucks carried the shorter distance passengers on their double cab for revenue between Aberdeen and Western District. Their unrestrained aggressiveness for business on the narrow Pok Fu Lam Road caused numerous clashes with the short wheelbase Mark V buses. On the other hand, it was observed that the disproportional power to payload ratio made these single deck units difficult to manoeuvre and insensitive to respond to the aggressiveness of the Leyland FGs. It was realised that the over-powered Mark V buses were required to be tamed, and the solution was rather drastic and novel.

In earlier time, following the occupation of Wah Fu Estate, the government widened Pok Fu Lam Road from dual lane to quadric lane. In preparation for managing the anticipated higher patronage to and from Wah Fu Estate, CMB added to its FPB fleet 8,534 mm long and 4,978 mm wheelbase Guy Arab V double deck buses in 1967. Equipped with Gardner 6LX engines and locally assembled Metsec double deck bodies, these vehicles designated “M” class were found adequate in tackling the hilly Pok Fu Lam Road, which inspired the CMB management to explore turning the short wheelbase Mark V into double deck, albeit 406 mm shorter in wheelbase than the “M” class. It was when the single deck conversion into double deck set sail in 1968.

Although the original mechanical configuration was over-powered for single deck version, it was insufficient for double deck operation. Therefore, these short wheelbase Mark V units were subject to mechanical enhancement with key features as tabled below:-

Mechanical Feature	Mark V Single Deck	Converted Double Deck
Gearbox	Guy semi-automatic gearbox	Daimler Daimatic semi-automatic gearbox
Wheels	900 × 20 tyres and rims	1100 × 20 tyres and rims
Rear Axle Ratio	5.6:1	6.25:1
Passenger Door	Manual doors for AD class Mark V	Additional electric door control units
Suspension	-	Additional leaf spring for heavier body

The converted units were designated “S” Class in the CMB fleet. The forerunner, S1, was experimented with the lower deck body frame constructed by CMB indigenously and the original single deck body removed, reconditioned and welded on top of the lower deck body frame with braces to form the upper deck saloon. The changes with respect to the preceding single deck model are compared as below:-

Mechanical Feature		Mark V Single Deck	Converted S-type
Engine	Model	Gardner 6LX	
	Output Power	135 b.h.p. / 100.7 kW	
Wheelbase		15' / 4,572 mm	
Overall Width		8' / 2,438 mm	
Overall Length		25'-1" / 7,645 mm	26' / 7,925 mm
Seating Capacity		30	63
Standing Capacity		18	16

Following S1 were few more units converted in the same arrangement. The initial idea was to construct the body indigenously so as to save time from ordering bus body components from the U.K. However, the local construction turned out to be more time-consuming than expected, which resulted in a slower conversion rate than the CMB management expectation. As a result, except for S2 and S3 which used the double deck body kits originally allocated for M43 and M44, the conversion was improved with the lower deck body parts purchased from Metsec and the upper body remained reusing the original single deck body. Shorter conversion time was achieved and total 49 S-type buses were rebuilt.

It is interesting to note that the conversion was reported by the noon newspaper at the time, the “Star Post”, in December 1970. The journalist conducted a detailed interview with the CMB management and reported the interview in seven (7) editions, with each time publishing a fraction of the full interview content, resulting in a day-to-day question and response scenario lasting for a week. The headline “CMB Builds 1<sup>st</sup> Bus in 7 Years” was misleading too, because it was not a fact that CMB built no bus in seven (7) years, and it was merely the case that it was the first time in seven (7) years for CMB to scratch build and convert a single deck bus into double deck. Above all, the conversion was the first time ever.

### **Go Double Low**

Although the conversion of the short wheelbase Mark V single deck buses into double deck ones provided an instantaneous solution of increasing passenger carrying capacity, part of the expanded services was pending a proprietary solution.

The service operating between the Central and the famous Victoria Peak was bus route 15, which ran underneath the Mount Kellet Road Bridge with a low headroom of 14’-4” / 4,368.8 mm. Route 15 had long been served by single deck buses which had never had a problem of passing through the bridge. However, the standard height of double deck buses in Hong Kong, including the S-type, was 14’-7” / 4,445 mm in order to fulfil the statutory minimum headroom requirements of 5’-9” / 1,752.6 mm and 5’-8” / 1,727.2 mm for lower deck and upper deck respectively. It would not be wise to dispatch double deck buses in standard height to clash with the bridge before reaching the Peak terminus, and CMB had to offer a tailor-made solution for the special route 15.

The solution was creating a vehicle class with the headrooms of both decks being compressed to confine the overall vehicle height to be 14’-2” / 4,318 mm. The 2” / 50.8 mm clearance would permit the double deck in such low height configuration to pass the bridge and climb to the Peak. This class was modified from the short wheelbase Mark V conversion, and total 19 short wheelbase Mark V chasses were re-bodied with combination of the Metsec-supplied brand new lower deck body kits and the original single deck body structure for the upper deck saloon. The Peak route specific converted Mark V buses, designated “LS” class, initially had their radiator grills painted in blue for differentiating them from their S-type cousins which had their radiator grills painted in cream colour, so that the operation staff could correctly dispatch only the LS-type to route 15 easily. Nevertheless, following the CMB fleet livery change from orange-red/cream to blue/cream, these blue grills did not stand out so much against the surrounding blue cowling.

### **Go Double Long**

The double deck capacity potential of all the 40 “Long Dragon” was explored following the successful conversion of the single deck short wheelbase Mark V to S-type and LS-type. The conversion of these “Long Dragon” buses came to its time when their body structures degraded prematurely.

In single deck, the “Long Dragon” had two (2) wide entrances; the entry gate located at the rear overhang and the exit gate mid-point between the two axles. The entire rear overhang saloon was for standees only without any seats fitted, and the passengers tendered their fare either to the seating conductor at the conductor booth above the near-side rear wheel-arch and moved towards the front of the saloon, or to the roving conductor at the front of the saloon. This configuration resulted in weight being concentrated at the back of the vehicle and the body structure at the rear was therefore quite excessively stressed, inducing substantial bending moment on the chassis. The pillars behind the front wheel and the front exit gate were thus more severely cracked than the other body structural members and were redressed by the application of additional struts for reinforcement.

In addition to the premature body structure failures, the sheer length of the “Long Dragon” was found unfit for the narrow and hilly roads on Hong Kong Island. Its 80' / 24,384 mm swept circle made manoeuvre in the narrow and busy streets difficult and dangerous and therefore it was only suitable for operation on limited boulevards between Chai Wan and Wanchai Ferry Pier. It was recorded that a schoolboy was hit by and squashed against another bus to death when a “Long Dragon” made a sharp turn in a terminus. A solution for resolving both problems was to convert the “Long Dragon” from single deck to double deck, with the chassis length reduced to align with the existing non-converted double deck buses in service. The features of the “Long Dragon” before and after the conversion are tabled as below:-

Features	Before Conversion	After Conversion
Overall Length	35'-9" / 10,896.6 mm	31' / 9,448.8 mm
Overall Wheelbase	22' / 6,705.6 mm	18'-6" / 5,638.8 mm
Seating Capacity	34	70 – 78
Standing Capacity	56	13 – 18
Turning Circle	76' / 23,164.8 mm	60' / 18,440.0 mm
Swept Circle	80' / 24,384 mm	-

For shortening the wheelbase, the original body was stripped down from the “Long Dragon” chassis, and so were the tubing, control wires, fuel tank and driving shaft removed. The bare chassis mid-point was cut in 55 degree from horizontal, dividing the front axle section and the rear axle section. A section 1,447.8 mm long was cut from the chassis and the remainder front and rear axle sections were joined together by welding. The angled joint was designed to provide additional reinforcement than conventional vertical joints as proved in the fullness of time. The converted chassis was refitted with tubing, control wires, fuel tank and driving shaft and was ready to receive a double deck body. Without differentiation from their “LX” class cousins in the CMB fleet which were double deck at the start, these “Long Dragon” converts were also identified as “LX” class.

Again in time when ordering brand new bus body kits from the U.K. was considered too lengthy to deliver readily available double deck buses for service, CMB strived various means to body these “Long Dragon” chasses after surgery as quickly as possible. Five (5) of them were given an attempt of local solution. A CMB bus body works contractor, Wong Chow Kee, was contracted to design, supply and install a complete double deck body for the shortened “Long Dragon” chassis. Three (3) bodies were constructed and licensed in 1971, followed by two (2) bodies in 1972.

Without prior experience of designing and constructing a double deck bus body from scratch, Wong Chow Kee's output was at long lead time and low production rate, prompting CMB to explore alternatives.

At this time, the U.K. entered the one-man-operation (OMO) era with rear engined buses. The conventional front-engined buses such as Mark V lost favour of many bus operators in the country and they were disposed of in large quantities. Plenty of second-hand complete buses were immediately available for sale in the market, which came under the eyes of the CMB management. In 1972, CMB purchased six (6) complete second-hand front-engined buses and shipped them to Hong Kong. Their A.E.C. and Guy Mark V chasses and power-train were not the CMB interest. Their bodies were transplanted to the shortened "Long Dragon" chasses and six (6) re-bodied units were put into service in 1972. This was found to be an immediate solution of acquiring double deck bus bodies, and in the following 1973 and 1974, six (6) units in each year received such conversion, resulting in 18 "Long Dragon" chasses in total being re-bodied in this method by 1974.

Although second-hand double deck bodies were handy to acquire, their age and U.K.-domain configuration, such as single door access to the saloon, were not suitable for the demanding operating environment specific to Hong Kong. A brand new purpose built body was the desired solution, and this time CMB turned to British Aluminium Company (BACO), a small-sized U.K.-based supplier of double deck body kits. 15 sets of kits were ordered and installed to put 15 converted "Long Dragon" buses into service in 1975.

In addition to removing the U.K. double deck body from scrap chassis for transplanting to the shortened "Long Dragon" chassis to reduce construction lead time, CMB also acquired in 1974 ten (10) Guy Mark V chassis, which had their prematurely fractured bodies removed in the U.K., for fitting converted double deck bodies in Hong Kong to be licensed as additional vehicles. CMB, eight (8) of them were fitted with Wong Chow Kee body like their "Long Dragon" cousins, whilst two (2) of them were re-bodied with BACO components in 1975 together with the last two (2) "Long Dragon" chasses. Therefore, from the first one in 1971, all the 40 single deck "Long Dragon" buses were converted to become "LX" class double deck by 1976.

However, the second-hand bus bodies from the U.K. was a short-term solution of maximising the passenger carrying capacity and could not be relied upon long-term. The long-term solution was to equip these "Long Dragon" chasses with brand new dedicated double deck bus bodies, and this time CMB sought assistance from Walter Alexander (Alexander), a small-sized bus and coach body builder in Falkirk of Scotland in the U.K. Alexander delivered 26 sets of kits to re-body all the 18 "Long Dragon" which were previously converted with second-hand bodies and eight (8) second-hand Mark V chasses, and this was the finale of all the double deckers designated as LX. The Alexander-bodied "Long Dragon" bus which were renowned for its advanced fibreglass body panels and interior formica fittings as compared with the conventional painted metal panels, appeared to be well-received, reflected by the height of LX217 at 4.4 m, which is equivalent to 14.5', being used by the government to illustrate metrication and promote the adoption of metrication in the society.



The alteration of chassis length in bus construction is not limited to the “Long Dragon” conversion back in 1970s. Modern new coaches are also built with extensive works on the original chasses. In order to save transportation cost by minimising the chargeable volume-based measurement tonne, the drivable chasses are shortened without the middle straight frame section but shipped with only the front and rear axle modules coupled with the complete power-train, axles and steering (every chassis comes with a plastic folding chair from the famous Swedish chain furniture store attached behind the steering wheel to permit the chassis to be driven to the port) with pre-installed cabling and tubing,. It is only when they enter the body builder shop, that the modules are decoupled and joined with a pre-fabricated mid-section steel frame by welding at both ends to form the necessary wheelbase, aided by laser-based alignment check. This has the full support from the overseas manufacturer and formal approval from the government. The frame provides the full length wheelbase of each coach and the structure of the under-floor luggage compartment. The frame and the chassis modules form the integral chassis to which the floor and side body structures are fitted by welding, forming the shape of the coach.

### **Front Versus Rear**

In response to the upsurge in passenger demand, CMB not only maximised its passenger carrying capacity by converting all its single deck Mark V buses into double deck, it also imported a number of complete second-hand buses from the U.K. for passenger service. Incidentally, it happened at the time when the U.K. bus market was transited from front-engined models to rear-engined models, the latter configuration was still in the early stage of development and was still under performance evaluation in terms of technical reliability. It was for this reason the first generation rear-engined configuration was not without criticism from the front-engined advocates, claiming the engine at the rear was in the wrong order with the phrase “put the cart before the horse”.

Indeed the rear-engined configuration inherited a few weaknesses with respect to the front-engined. For the bus companies, its complicated and unreliable angle drive made mechanical reparation and maintenance difficult and costly. The radiator in the early days of the rear-engined buses was insufficient and the engine was thus susceptible to over-heat. In case of vehicle break-down, towing recovery was inconvenient because there was no attachment point for the hook or the towing rod. For the bus drivers, its long front over-hang and larger swept circle impeded manoeuvring. Being far from the engine, the driver was unable to be aware of the engine condition and observe any anomalies. Also, without the engine and chassis members at the front to function as crash barrier and as a partition from passengers, it offered poor protection from crash impact and passenger assault respectively.

Flipping the other side of the same coin, however, the rear-engined configuration has advantages. For the bus companies, with both the engine and gearbox co-located at the rear, access of which for reparation and maintenance became easy and convenient. Its low centre of gravity (CG) offered higher stability and lower risk of over-turn. For the drivers and passengers, it offered lower ground clearance which resulted in easy passenger embarkation and disembarkation and made disabled passenger access feasible. Furthermore, not only did it remove the partition between the driving cab and the entry which provided better contact with passengers, but also enabled the

saloon door to be located side-by-side to the driving cab, facilitating OMO. The engine noise was removed from the saloon and so were the associated heat and noise, creating a more comfortable driving and riding environment. Finally, steering was made easier with the weight of the drive train distributed away from the front axle.

The strengths and weaknesses of the front-engined configuration were about the exact opposite of the rear-engined configuration. The front-engine configuration merited simpler drive-train design and less complicated cabling and tubing, more efficient engine cooling, easier towing recovery and better manoeuvre given by shorter front over-hang and hence smaller swept circle. Furthermore, the driver could be instantly aware of the condition of the engine, and better protected from front collision. The shortfalls included inconvenient access to and hence the reparation and maintenance of the engine and gearbox, high CG led to higher risk of turn-over, poor passenger embarkation and disembarkation due to high ground clearance, impediment of OMO, poor driving cab access, hot and noisy saloon and heavy steering.

In the U.K., buses in front-engined and half-cab (i.e. the driving cab and the engine bonnet cover are side-by-side at the front and the saloon door is behind the driving seat) configuration, which was the layout used in Mark V, did not facilitate OMO on the ground of frequent turning round the driver's head to monitor fare collection jeopardising occupational health. On the contrary, Hong Kong extensively executed OMO in the front-engined half-cab FPBs, whereby the fare box was installed next to the saloon door at the back of the driving cab. While both CMB and KMB operated front-engined half-cab double deck buses in OMO, behind the driving cab of each of the KMB buses was a pillar at the centre front of the lower saloon, monitoring of fare collection was difficult as the vision of the driver on the fare box was blocked. CMB overcame this intrinsic limitation of the front-engined half-cab layout by the invention of Angled Bulkhead, which offset the front lower saloon window behind the engine compartment towards the front, creating a void between the driver seat and the saloon so that the driver could easily monitor the saloon over his shoulder. The fare box was located within the normal visual range of the driver, albeit still behind the driving cab, so that all fare tendering was under the driver's close eyes.

### **The Rear Pride**

Notwithstanding the criticism, the U.K. bus market had embraced rear-engined buses due to their enablement of OMO. The wave of rear-engined configuration had been irresistible through substantial government subsidy, and the major bus manufacturers in the U.K. therefore abandoned production of front-engined models, thereby causing adverse effect to the fleet expansion programme of both Hong Kong companies. Subsequently both CMB and KMB had to march into the rear-engined buses era with the counterparts in the U.K., albeit without any government subsidy.

The pioneer first generation rear-engined double deck bus in Hong Kong, a 30' / 9,144mm long Daimler Fleetline, joined the CMB fleet in the first quarter of 1972, with fleet number "RLX1" and subsequently "SF1", when all double deck buses at the time were front-engined half-cab. The arrival of the novel RLX1 coincided with Hong Kong Festival, the colonial government-organised campaign to build sense of belonging of the residents to the territory in the early 1970s. The summit of Hong Kong Festival was an evening street parade, and CMB dispatched RLX1 clothed in

sequential flashing light bulbs and Hong Kong Festival decorations. Two (2) packet diesel generators had to be carried on board to meet the additional power demand of illuminating the light bulbs in order to make RLX1 an eye-catching exhibit in the parade.

After CMB was satisfied with the trial, it introduced longer Daimler Fleetline buses in large scale, in 33' / 10,058 mm length, into its fleet from the third quarter of 1973. KMB, however, did not experiment with any rear-engined model but would rather like to observe the performances of the new vehicles in the CMB fleet. It was in the second quarter of 1974 that KMB introduced Daimler Fleetline, all 33' / 10,058 mm long into service.

These longer brand new Daimler Fleetline buses in the CMB fleet, which were designated "LF" class, were the pride of their owner at the time and a new fleet livery was considered. Rarely known is that in addition to its FPB services, CMB also offered chartered service to organisations. Once Hong Kong Aircraft Engineering Company Limited (HAECO), the provider of aircraft overhaul, repair and maintenance services in Kai Tak International Airport in Kowloon, organised an one (1) day outing for 2,000 of its employees in the New Territories, and chartered CMB double deck buses to convey its employees between the HAECO facility in Kowloon and the outing place. CMB dispatched brand new LF units for the HAECO order and, utilising the waiting time between the outbound and inbound journeys, eight (8) of them which carried various trial liveries assembled on the cleared site of the demolished Kowloon Terminus of the Kowloon-Canton Railway Corporation, where is nowadays the site of Hong Kong Culture Centre by Salisbury Road in Kowloon. Lined-up with the iconic Star House at the background, they were taken in a photograph to be featured on the front cover of the CMB Annual Report in showcasing the company's investment on modern vehicles for its business.

### **Front and Rear**

Nevertheless, the first generation rear-engined buses in the early days did not fit the more-than-expected demanding operating conditions in Hong Kong, and their availability and reliability were far below the FPB operators' expectation. Both CMB and KMB were unconvinced that rear-engined buses were the right solution, and they therefore attempted to return to the front-engined layout. In the same period when KMB added Daimler Fleetline to its fleet, CMB tried an India-built Ashok Leyland PD (APD). It was and has remained to be the first and only double deck bus imported from India to Hong Kong. Completely built-up, it was designed to suit the Indian operating conditions. For instance, standee in Hong Kong was and is prohibited on the upper saloon of a double deck bus, this APD was fitted with roof hand rails in the upper saloon, implying standees on the upper deck were permitted and commonplace in India. Owing to the unsatisfactory performance of its Leyland engine, APD was not favoured by the CMB management, and it had no companion in Hong Kong until withdrawal from service and subsequent scapping.

After APD, CMB also experimented with another front-engined model, Alisa-Volvo B55 from Scotland (AV class) in the fourth quarter of 1975. AV featured the front saloon door located before the front axle which facilitated OMO, and longer AV buses were added to the fleet in the following year. In the same period, however,

KMB sourced front-engine buses from scratch. Contrary to CMB who tried readily available products in the market, KMB appealed to the U.K. bus manufacturers for a bespoke solution, and this time the eyeball turned to South Africa.

In South Africa, both Leyland and Dennis offered the front-engined chassis models, namely Victory J and Jubilant, for double deck application respectively. Bodied by the local bus body builder BUSAF, they both featured the provision of saloon door before the front axle same as AV, and were hence suitable for OMO. KMB imported four (4) South Africa-built double deck Victory J buses for trial in the first quarter of 1976 and obtained satisfactory results. By basing on this body layout, KMB ordered customised Leyland Victory II and Dennis Jubilant prototypes from the U.K. in late 1977 for further trial. Both models were up to KMB satisfaction, and large orders of the successor of African Victory J, Leyland Victory II, and Dennis Jubilant, followed with their U. K. manufacturers.

In the same period, while CMB tried the second generation rear-engined Metrobus and Dominator of Metro Cammell Weymann and Dennis sold in the U.K. respectively, it observed the performances of the latest front-engine offers of Victory II and Jubilant on the KMB side. With the proven robustness of the front-engined buses in the KMB fleet, CMB also added Victory II (“LV” class of CMB) to its fleet in the fourth quarter of 1979. Jubilant (“DS” class of CMB) arrived CMB in the first quarter of 1980, and so was the second generation rear-engined Titan of Leyland.

Even though the modern front-engined Victory II and Jubilant proved their value to the FPB operators in respect of technical reliability, they were unable to over-turn the trend of going rear-engine. They were also the final front-engined double deck bus models operating in large numbers in Hong Kong, and all buses, both single and double deck, procured by the FPB operators were all rear-engined afterwards.

### **Front Accomplishments**

Even so, at the time when passenger patronage surged in consequence of a series of social development, such as the large scale occupation of new housing developments, labour law improvements, new attraction and improved road network, the new front-engined models, be them S, LS, LX, LV or DS, together with the second-hand double deck buses imported from the U.K., offered immediate solutions of expanding the CMB passenger carrying capacity to meet the increasing demand and hence improve its service. The creation of S, LS and the converted LX by the unprecedented conversion from single deck to double deck underwent the due engineering process of bus type design, prototype production and modification for passing statutory inspection in order to produce the first vehicle for testing the viability of the concepts in terms of road worthiness, serviceability and reliability. Since it was the creation of new vehicle types, the government was involved in the process of the development of the prototype until it was granted Type Approval, which was prerequisite for commission for service. Eventually, the models were accepted and they delivered service to passengers.

The change they brought to the CMB fleet composition was significant. In 1969, about 70 % of the 300-plus CMB buses were single deck. By 1976, however, all single deck buses had been either withdrawn or converted into double deck units and

the fleet size had expanded two (2) folds. The converted LX was the backbone model of the 900-plus all double deck strong fleet. Also, in a decade between 1970 and 1980, the passenger carrying capacity of the CMB fleet expanded four (4) folds.

The radical single-to-double deck conversion of the Mark V buses was devised entirely by the CMB personnel with suitable blessing from the original chassis manufacturer, Guy Motors since the Mark V chassis was fitted with double deck body in the U.K. No sophisticated data analysis by today's standard was involved in deciding the schemes of the conversions, including the upgrade of the mechanical configuration, the integration of the lower and upper body structure and the surgery on the chassis. Rather, they were decided with the experience, soberness and confidence of the CMB engineering personnel, who knew every character and potential of the Mark V chassis. The converted units had served faithfully till the end of their extended service lives, when they were withdrawn and scrapped, and no premature mechanical failure was observed. The empirically designed conversion proved its outstanding soundness with time, which in itself was an engineering establishment. Engineering responded the call of the time and delivered solutions for the needs, improving the lives of the residents of Hong Kong with the widened mobility.

Moreover, salient to note is that the operating conditions of Hong Kong are recognised the most demanding for municipal buses in the world. Not only was it demonstrated in the above CMB history, stepping into 1980s, success of three-axled high capacity double deck, air-conditioned double deck, step-free entry double deck and more in Hong Kong were all major breakthroughs in double deck bus technology one after another. They were all invented for, experimented successfully and perfected in Hong Kong, and then radiated to all over the world where they are called to serve. Hong Kong is the forefront of double deck bus development and the harshest testing ground for new bus designs. The track record of a well proven double deck bus model in Hong Kong is in fact a passport of global acceptance.





*Institution of Mechanical Engineers Hong Kong Branch Past Chairman, Mr. Edmund K.H. Leung, presented Certificate of Appreciation to the speaker, Mr. Selwyn S.H. Lai*

Institution of Mechanical Engineers Hong Kong Branch thanks Mr. Selwyn S.H. Lai for his generous sharing of the interesting chapter of the history of road transport of Hong Kong.

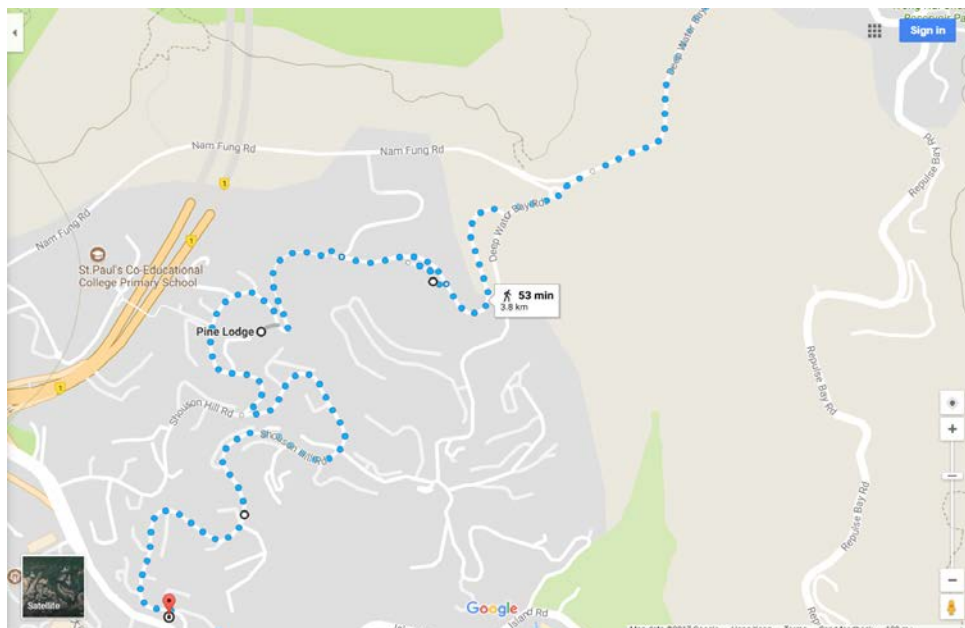
Photographs were taken by Mr. Benny C.Y. Sit with permission to use. Copyright reserved.

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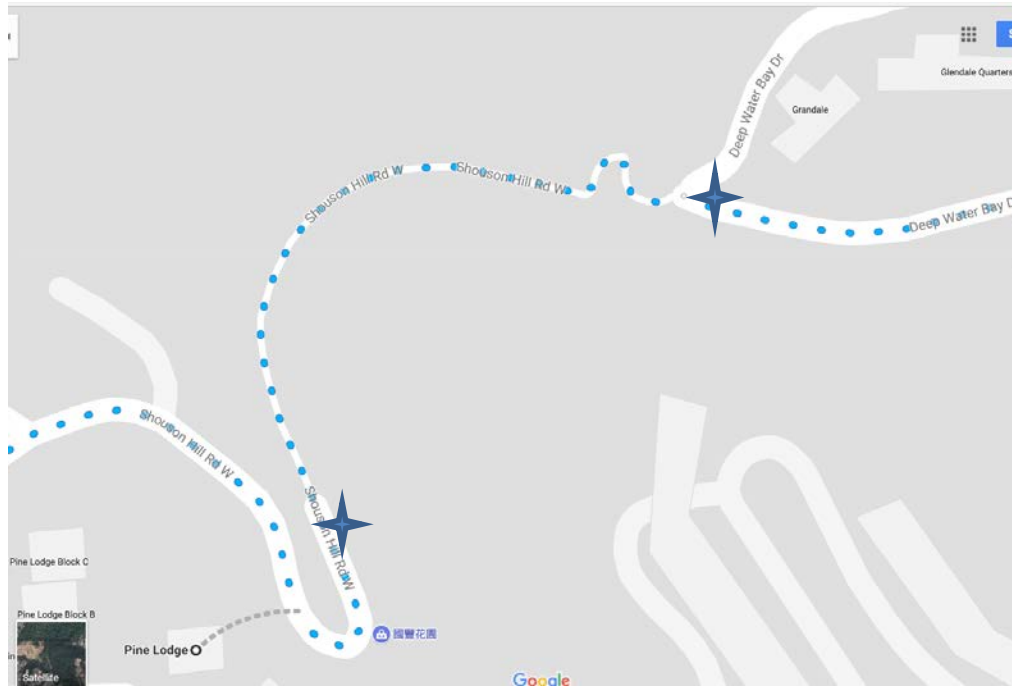
## **Nam Fung Road and Aberdeen**

Before Nam Fung Road was opened, private cars could use Deep Water Bay Road, Deep Water Bay Drive and Shouson Hill Road West to proceed from Wong Nai Chung Gap Road to Aberdeen but large vehicles such as buses could not pass a very narrow single track stretch of Shouson Hill Road West (as shown in the maps below). Bus passengers going from Eastern District to Wong Chuk Hang had to travel on Route 2 or 10 to Central first, then Route 7 to Aberdeen and change to Route 7A at Aberdeen. The opening of Nam Fung Road in July 1973 provided a direct link between Eastern District and Aberdeen and Wong Chuk Hang areas.

In August 1975, Route 72 was introduced between Aberdeen and Causeway Bay (Moreton Terrace) via Nam Fung Road to facilitate Eastern District bound passengers after occupation of Phases 2 and 3 of Wong Chuk Hang Estate which had been completed in 1972 and 1973 respectively and more factories had been opened in Wong Chuk Hang area. Part of the reason for the deferred introduction of Route 72 to 1975 was caused by the priority to deploy enough short S and M type double deckers to Aberdeen and Wah Fu Routes first before further numbers could be allocated to start the new Route 72 to manoeuvre some super narrow and steep sections of Deep Water Bay Road and Nam Fung Road.



Old route via Shouson Hill Road West for cars only.



Inset of narrow section of single track road between the two crosses  
marked above.

The opening of Yee King Road between Tin Hau Temple Road and Lai Tak Tsuen Road in January 1975 also provided a shortcut between the hilly areas of Causeway Bay and North Point to cater for the opening of the new Lai Tak Tsuen in May 1975.

Route 41 was introduced between North Point Ferry and Wah Fu Estate in November 1976 via Yee King Road, Lai Tak Tsuen Road, Tai Hang Road and Nam Fung Road. This route not only provided the Lai Tak Tsuen residents with a two- pronged bus service to North Point to the East and Aberdeen, Wong Chuk Hang and Wah Fu areas to the South, but also added a quick shortcut between the East and the South for Hong Kong Island passengers by bypassing the congested Causeway Bay. Route 72 and 41 were well utilised on weekdays by the employees of factories in Wong Chuk Hang and Tin Wan Areas which had since grown in large numbers in the Seventies.

The opening of Ocean Park in January 1977 created additional patronage for these routes, particularly at weekends. New CMB bus services introduced in January 1977 to cater for the park visitors included:

- Route 48 between Wah Fu and Wong Chuk Hang Estate on weekdays and extended to Ocean Park on Sundays and Public Holidays
- Route 71A between Central Terminal and Ocean Park via Aberdeen on Sundays and Public Holidays

From January 1977, detours via Ocean Park were also made on existing routes

- on route 41 on a daily basis with supplementary departures from Ocean Park to North Point in the evening peak,
- on route 72 on Sundays and Public Holidays with supplementary departures from Ocean Park to Causeway Bay in the evening peak.
- On tunnel route 170 on Sundays and Public Holidays only.

## **Time Line**

1972 – Wong Chuk Hang Estate Phase 2 was occupied (4 blocks)

1973 – Wong Chuk Hang Estate Phase 3 was occupied (4 blocks)

July 1973 -- Nam Fung Road was opened –

January 1975 – Yee King Road was opened --

May 1975 – Lai Tak Tsuen Phase I was opened --

- August 1975 – Route 72 introduced between Aberdeen and Causeway Bay (Moreton Terrace) via Nam Fung Road to facilitate Eastern District passengers,
- October 1975 - Route 170 introduced between Aberdeen and Shatin via Lion Rock Tunnel and Nam Fung Road on Sundays and Public Holidays only to facilitate Kowloon passengers,
- November 1976 – Route 41 introduced between Wah Fu Estate and North Point Ferry Pier via Nam Fung Road and Yee King Road to facilitate North Point, Lai Tak Tsuen and Tai Hang Road passengers

January 1977 – Ocean Park was opened (now celebrating 40<sup>th</sup> anniversary from January 2017) –

## Appendix: Supplement Information of Nam Fung Road and Ocean Park

- Route 41 routed round Ocean Park Road daily with supplementary service added from Ocean Park in the evening peak on Sundays and Public Holidays,
- Routes 72 and 170 routed round Ocean Park Road on Sundays and Public Holidays with supplementary service added from Ocean Park to Causeway Bay on Route 72 in the evening peak,
- Route 48 introduced between Wah Fu and Wong Chuk Hang daily and extended to Ocean Park on Sundays and Public Holidays,
- Route 71A introduced between Central Terminal and Ocean Park via Aberdeen on Sundays and Public Holidays.

--- --- ---



# Engineering Match in 70s

High temperature, high humidity, frequent start-stop, frequent over-loading, high gradient, narrow road gauge ..... Hong Kong roads are served by custom-made buses to meet all the exotic demands. In the less technology advanced 1970s, how the bus operator utilise the automotive technologies available at its time to meet the operating needs? IMechE Hong Kong Branch will look into history and review the engineering solutions offered at its time and how the lessons may provide reference for today's challenges.



Photograph is contributed by Mr. Selwyn Lai with permission to use; copyright

For details, please scan the above QR code or visit IMechE webpage:  
<http://nearyou.imeche.org/near-you/north-east-asia/hong-kong/events>

*Free admission, 100 seats offered on first-come-first serve basis*

**Date:** 15 August 2017  
**Time:** 18:30 to 20:30  
**Venue:** PQ303, The Hong Kong Polytechnic University



# Engineering Match for Bus Operations in the '70s



Selwyn S H Lai  
August 2017

# Brief C V

- Member of Chartered Institute of Transport, 1985
- Associate Fellow of China Hong Kong Permanent Way Institute, 1997

## ▶ *China Motor Bus : 1968 - 1979*

- ▶ Traffic & Discipline

## ▶ *Hong Kong Telephone Co. : 1979 - 1987*

- ▶ Internal Distribution & Heavy Lifting

## ▶ *Kowloon Canton Railway : 1987 - 2007*

- ▶ Bus Division set up & operations
- ▶ East Rail operations
- ▶ Light Rail operations
- ▶ East Rail Extensions Planning for constructing Tsim Sha Tsui Extn, Ma On Shan Line & Lok Ma Chau Spur Line

## ▶ *Mass Transit Railway Corp. : 2007 - 2010*

- ▶ West Rail, Light Rail & Bus operations
- ▶ East Rail & Ma On Shan Line operations

- Chairman -
  - Hong Kong Transport Society
  - (香港巴士迷會)



鐵人暖心慈善基金會 是在香港註冊的  
 的昇平利慈善團體，旨在透過會員的積極  
 參與，扶助香港及內地貧困兒童及長者。  
 自2008年成立以來，參與的慈善項目包括  
 支援受5.12汶川地震破壞的學校復課及  
 賑災、在內地助學，興建小學生用綜合樓，  
 捐贈圖書，以及資助本港有需要的貧困學  
 童和長者。本會的工作目標是善用捐款，  
 向受惠者提供直接到位的援助。

歡迎支持本會宗旨的人士加入成為會員，  
 並參與會務。會員的權利包括選舉執事，  
 被選為執事，參與本會活動及提出改善會  
 務的意見等等。亦希望各界熱心公益人士  
 支持及慷慨捐助。

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- Vice Chairman -
  - Trainx Charity Foundations
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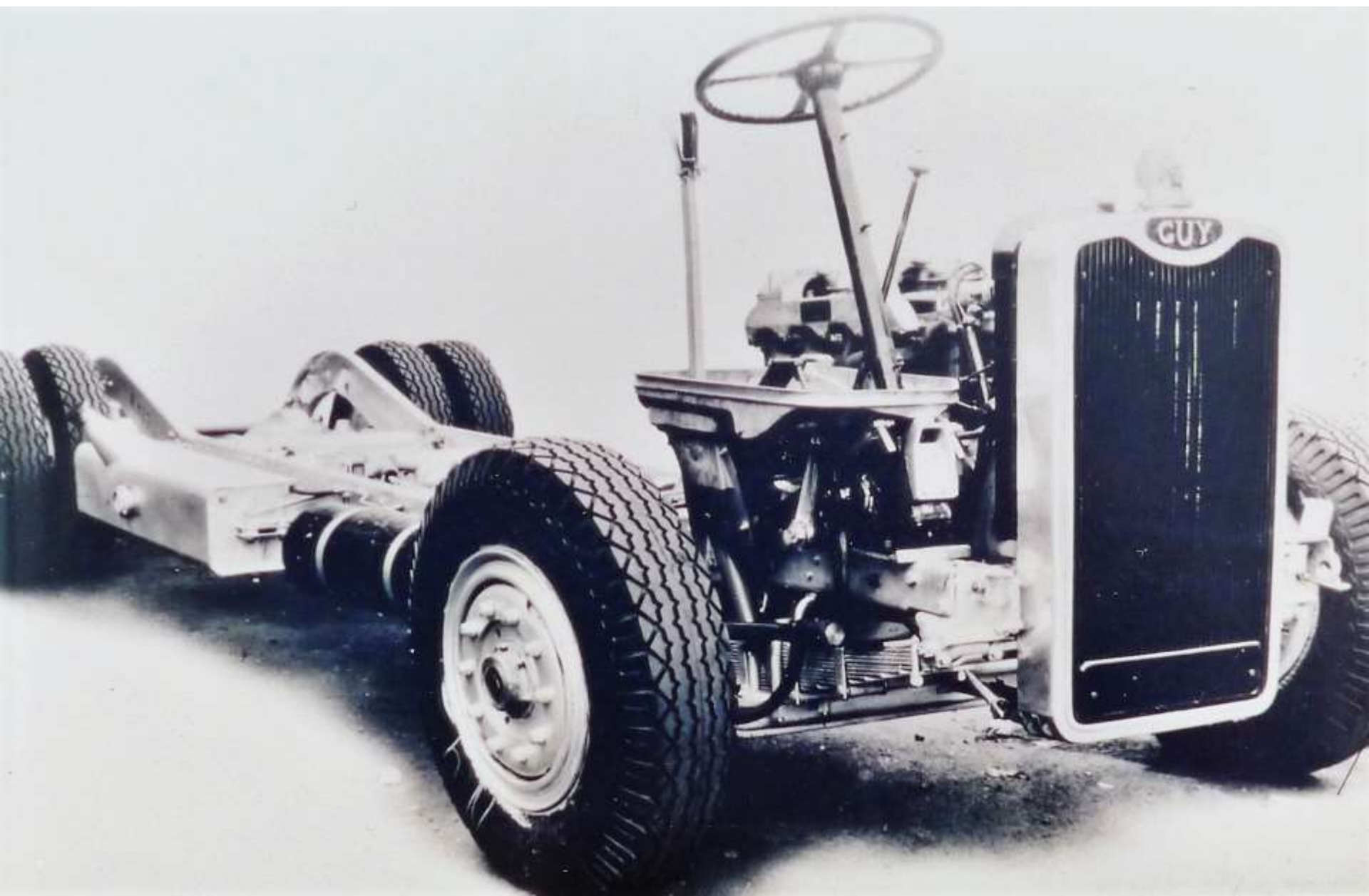


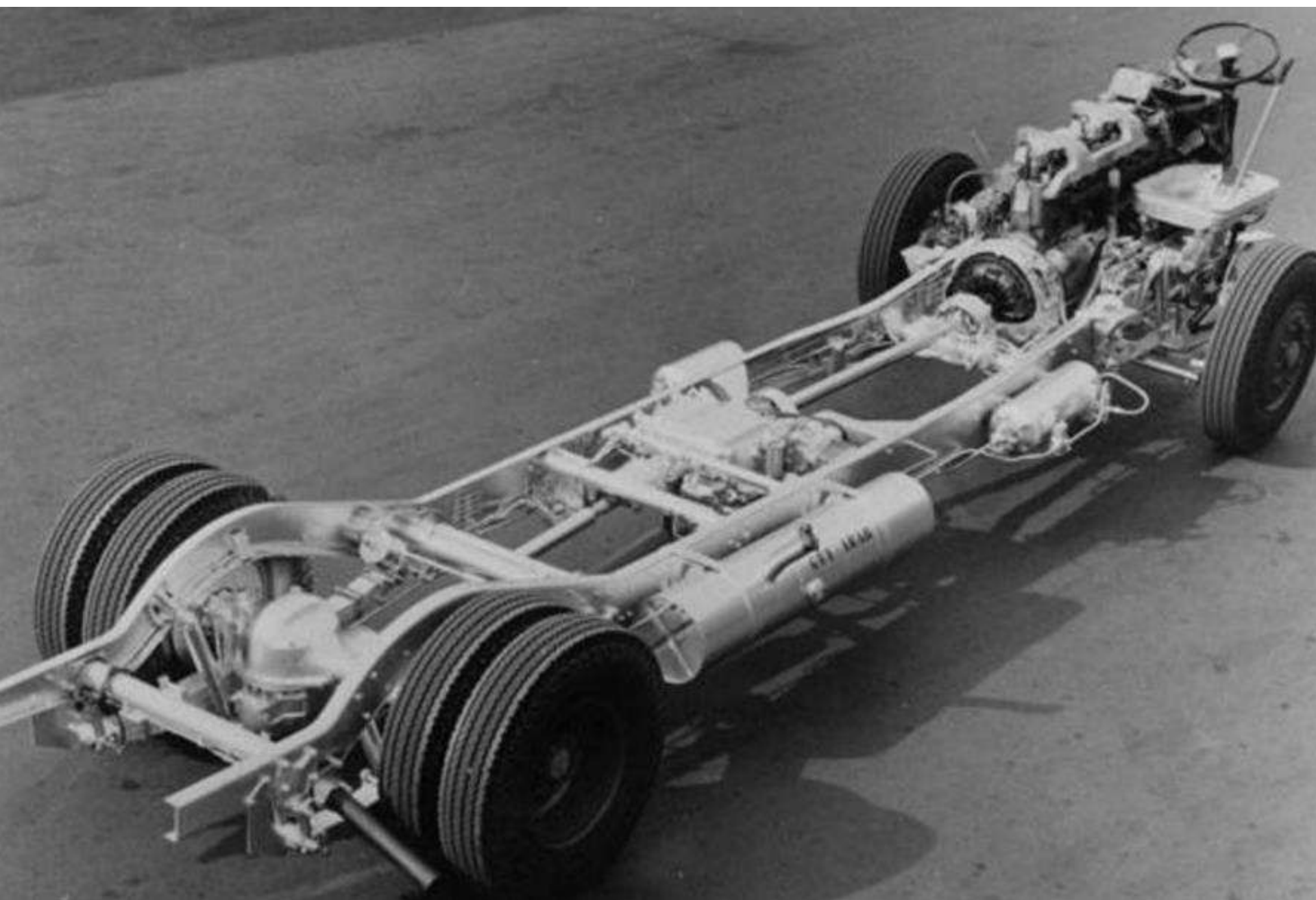
















## *The 'Guy Arab'*

DOUBLE DECK PASSENGER CHASSIS

One of a large fleet of "GUY ARAB" Double Deck Buses  
supplied to Southampton Corporation Transport

GUY MOTORS LTD.



WOLVERHAMPTON.ENG





## **Guy Arab Mk.V with one step entrance...**



### **Still the most economical front engined double decker bus chassis on the market!**

The versatile Arab Mk.V continues to offer outstanding qualities of performance and economy for all-route operation. The low-height chassis is suitable for bodies of up to 74 seats capacity and offers high efficiency under widely varying conditions.

#### *Arab features in demand are:*

Gardner 6LW, 112 b.h.p. diesel engine for economy and reliability.

Full air brakes with automatic brake adjusters.

Good accessibility for maintenance.

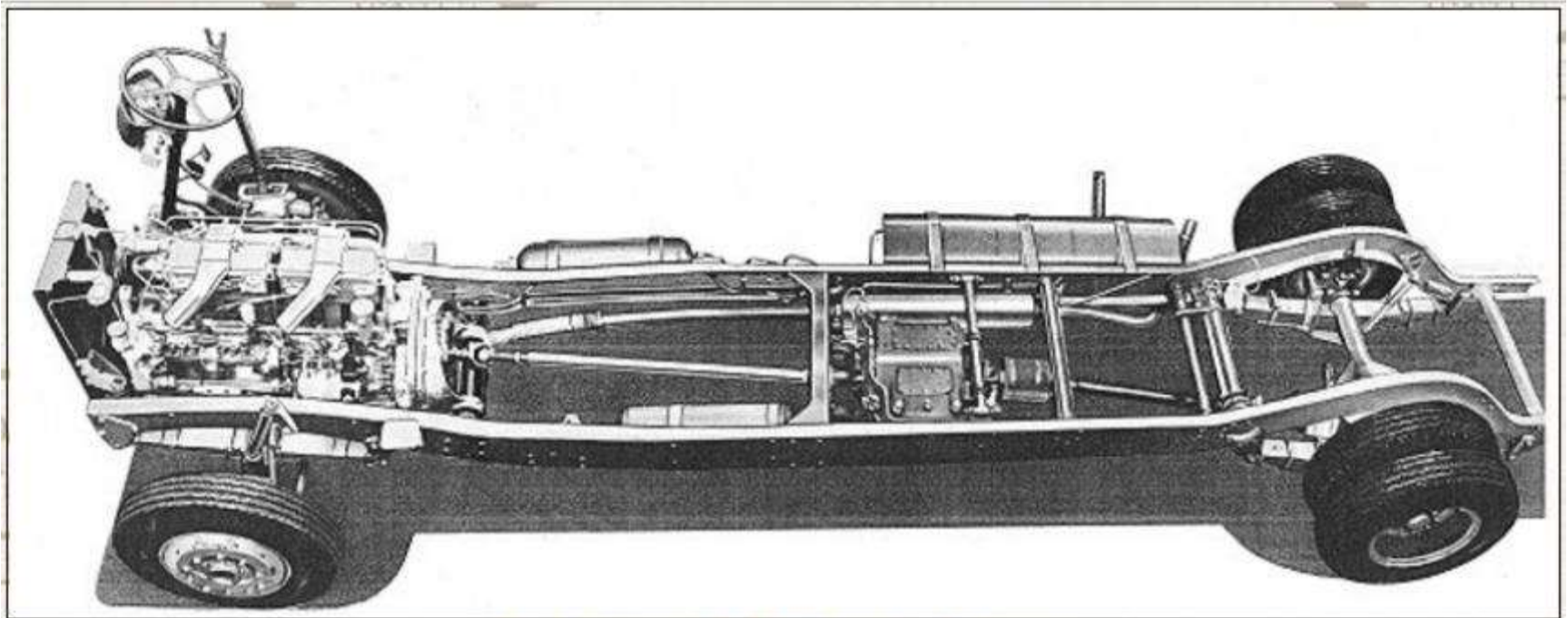
Full technical details and specification are available on request.

# **GUY**

GUY MOTORS LTD. WOLVERHAMPTON

Phone 32289. A subsidiary of Jaguar-Carri Ltd.





The 'Arab' mark 5 double deck chassis.



# New Low-frame Guy Arab Chassis

THE latest version of the Guy Arab double-decker bus chassis, the Mark V model, has a modified frame design to permit the use of a lower floor level. With forward-entrance bodywork, this is claimed to make possible the use of only two steps of normal height to gain access to the interior. The main portion of the side-members has been lowered  $2\frac{1}{2}$  in., as compared to the existing Mark IV model, giving a laden frame height of 1 ft. 9 $\frac{1}{2}$  in. This is only about 3 to 4 in. higher than the various low-floor double-decker models of unorthodox layout, yet the Arab V is otherwise entirely conventional in design.

The main mechanical units are those used on the present Mark IV model. The standard engine is the Gardner 6LW unit, although the 6LX and, in certain

cases, the 5LW engine of the same make are offered as alternatives. The front engine mounting continues to be of the two-point type incorporating inwardly inclined bonded rubber sandwich blocks. At the rear, a system similar to that used on the Invincible goods models has now been adopted. This incorporates large bonded rubber bushes mounted one at each side of the flywheel housing, with a stout tubular cross-member passing through them.

Transmission alternatives are a single-plate clutch and four-speed constant-mesh gearbox or fluid flywheel and four-speed direct-acting air-operated epicyclic gearbox giving two-pedal control. In both cases the gearbox continues to be mounted amidships.

The rear axle is an underslung worm-driven unit, with 8-in. worm centres, whilst the front axle is an I-section beam unit with 2 $\frac{7}{8}$ -in.-dia. stub axles. Road

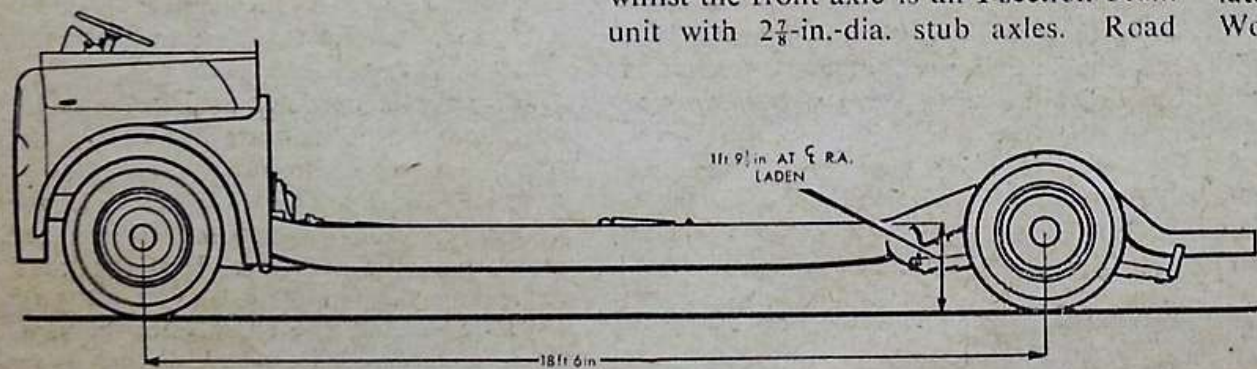
springs 4 in. wide are used for both axles in conjunction with telescopic dampers.

The air-pressure braking system incorporates diaphragm brake chambers in place of the cylinders used on the Arab IV.

The new side members are 10 $\frac{5}{16}$  in. deep,  $\frac{1}{4}$  in. thick and have 2 $\frac{3}{8}$ -in.-wide flanges at the point of maximum section. They terminate just behind the rearmost spring shackles, but dropped or straight extensions can be provided.

The wheelbase of the Arab V is 18 ft. 6 in. and the chassis is being offered in a form suitable for vehicles of approximately 30 ft. overall length only. Among the optional extras are automatic chassis lubrication and 24-volt A.C. electrical equipment.

The Arab V is going into production later this year and an example for Wolverhampton Corporation is to be exhibited at the Commercial Motor Show at Earls Court in September. The new model is of particular interest as it is the first to be announced by Guy Motors (Europe), Ltd., since the take-over by Jaguar Cars, Ltd. The Wulfrunian is not being displaced by the Arab V, which has been developed in response to continuing demand for a double-decker chassis of orthodox layout.



*The frame of the Arab Mark V is designed to give a low floor height.*



## **ENGINE**

Gardner 6LW 8.4 litre, 6 cylinder diesel, 112 b.h.p.

## **ENGINE MOUNTING**

Two-point 'Triangular' type front mounting, engine supported on sandwiched bonded rubber. Rear support is through bonded rubber bushes each side of flywheel

## **TRANSMISSION**

(A) Single dry plate clutch of the 'open' type, liners being  $15\frac{1}{8}$ " diameter  $\times$   $\frac{1}{8}$ " thick, total effective area—approximately 270 sq. ins. Four-speed, constant mesh gearbox, independently and flexibly mounted amidships in the chassis. Gears selected by centrally mounted ball type

## **PROPELLER SHAFT**

Open, tubular shafts, furnished with needle roller universal joints. Each joint fitted with shield to prevent oil throwing.

## **FRONT AXLE**

'I' section axle beam, of great strength, has integrally formed spring pads.

## **REAR AXLE**

Fully floating, underslung worm driven type, offset to nearside of chassis for minimum floor height.

## **FRAME**

Bolted assembly throughout.

## **ROAD SPRINGS**

Semi-elliptic leaf springs, 4" wide front and rear.

## **STEERING**

Cam and double roller type 28.5 to 1 ratio, giving smooth and easy steering, together with light castor return action. Steering wheel diameter 21".

## **BRAKES**

Full air pressure brakes, cam operated type, incorporating diaphragm type actuators.

## **RADIATOR**

All bolted construction with easily detachable units.

## **WHEELS AND TYRES**

11.00—20 (12 ply) front tyres on B7.5 wheels, offset  $5\frac{1}{8}$ "; Twin 9.00—20 (12 ply) rear tyres on B6.5 wheels, offset 5.6".

## **FUEL TANK**

35 gallons capacity, welded steel tank, well baffled for rigidity. Quick-action filler cap.

## **ELECTRICAL EQUIPMENT**

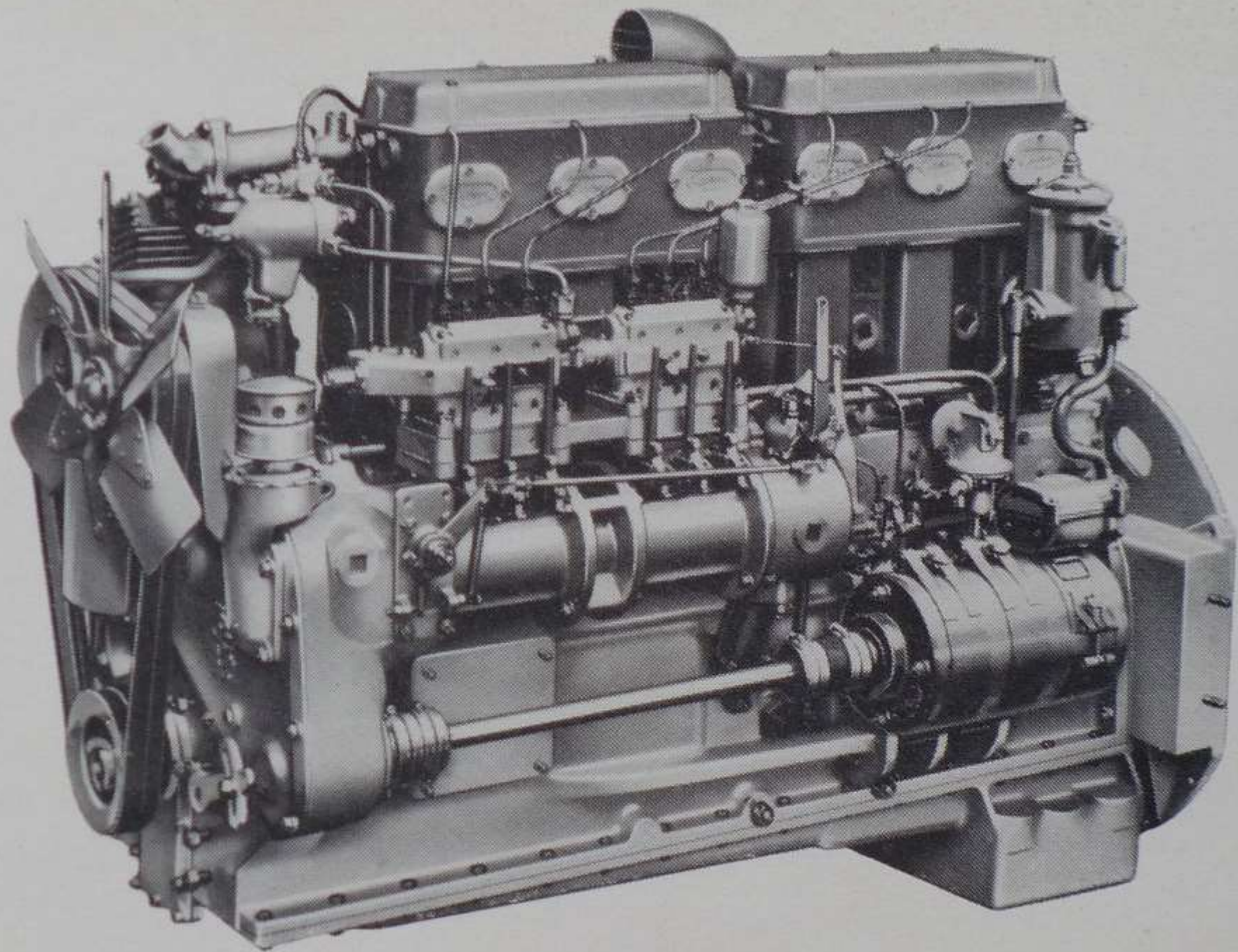
Compensated voltage control, 24-volt lighting and starting, insulated return, including:—DYNAMO: C.A.V. type DO7  $\times$  24.

## **CHASSIS LUBRICATION**

Independent nipples of the hook-on type at all points requiring lubrication. Automatic lubrication, air operated or belt driven, can be installed if required.

## **TOOL KIT**

Comprehensive engine kit, 6-ton hydraulic jack and wheelbrace supplied with each chassis.







For Work,  
Shopping,  
Or  
Pleasure,  
Travel by  
Bus, Tram  
&  
Trrolleybus.

Y COS  
HMER  
THE SUB  
RAILWAY







# Guy Arab Single Deckers

## Mk. IV

- ▶ Gardner 5LW with 95 b.h.p.
- ▶ 12 volts
- ▶ Pre-selector Gearbox
- ▶ Clutch pedal operation
- ▶ Servo Brakes with Cylinders
- ▶ 14 ft. 6 in. wheelbase
- ▶ 25 ft. long
- ▶ 7ft. 6 in. wide
- ▶ 30 seats
- ▶ 14 standees

## Mk. V

- ▶ Gardner 6LX with 135 b.h.p.
- ▶ 24 volts
- ▶ Electro-Pneumatic Semi-Automatic Gearbox
- ▶ Air Pressure Brakes
- ▶ 15 ft. wheelbase
- ▶ 25 ft. 1 in.
- ▶ 8 ft. wide
- ▶ 30 seats
- ▶ 18 standees





# *Route Constraints and Characteristics*

- ▶ Tight bends
- ▶ Steep gradients
- ▶ Width constraint
- ▶ Height constraint
- ▶ Low bridge
- ▶ Increased demand







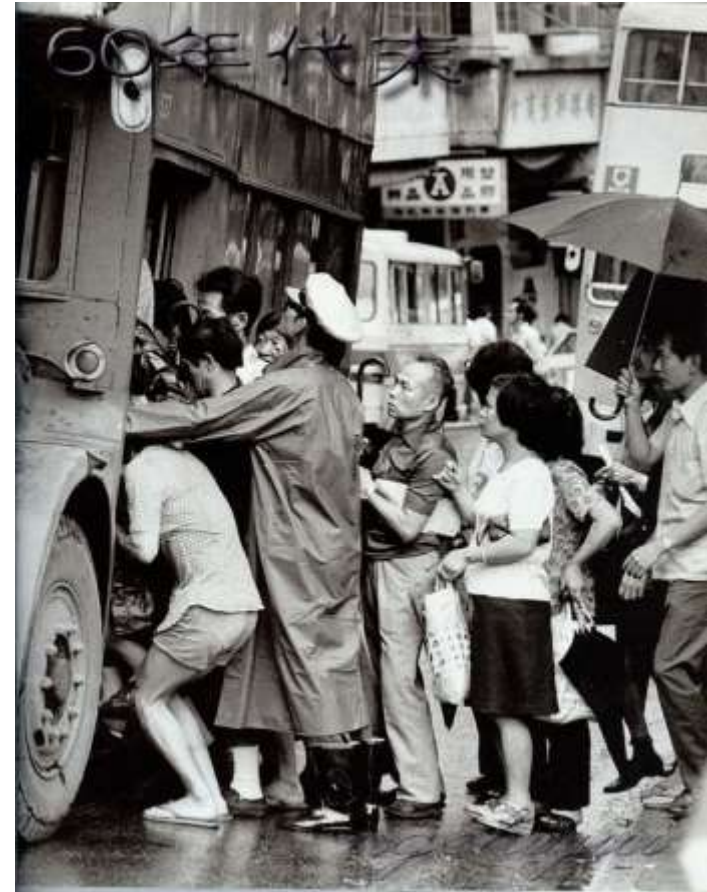








# New Public Housing Estates



# 1969 Wah Fu Estate





# 1970 - Wong Chuk Hang Estate



# 1970 Chai Wan Estate Phase II





# 1976 - Lai Tak Tsuen



# *New Developments & Attractions*

Cross Harbour Tunnel 1972

Mid Levels Bus Lanes 1974

Nam Fung Road 1976

Ocean Park 1977













**Bonham Road  
& Park Road**

 **13 min**  
3.3 km

**Caine Road &  
Arbuthnot Road**

**2 Robinson Road**

















# *New Labour Laws*

- Weekly rest day 1970
- Statutory Holiday 1973
- Annual leave 1977











STANLEY FORT  
赤柱砲台  
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14

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CMB



# TRIPLE SMASH AT POKFULAM!

10/70





司公限有運貨

LEVLAND

CR 1167



# Engineering Enhancements for Double Deck Conversion

## Mk V Single Deck

- ▶ Guy semi-automatic gearbox
- ▶ 900 x 20 tyres & rims
- ▶ 5.6 :1 rear axle
- ▶ Manual doors for AD class Mark V

## S Type Double Deck

- ▶ Daimler Daimatic semi-automatic gearbox
- ▶ 1100 x 20 tyres & rims
- ▶ 6.25 :1 rear axle
- ▶ Additional electric door control units
- ▶ Additional leaf spring for heavier body







# Guy Arab Single to Double Deckers

## Mk. V

- ▶ Gardner 6LX
- ▶ 135 b.h.p.
- ▶ 15 ft. wheelbase
- ▶ 8 ft. wide
- ▶ 25 ft. 1 in.
- ▶ 30 seats
- ▶ 18 standees

## S Type

- Gardner 6LX
- 135 b.h.p.
- 15 ft. wheelbase
- 8 ft. wide
- **26 ft.**
- **63 seats**
- **16 standees**

















# CMB BUILDS 1st BUS IN 7 YEARS

12/70



**T**HE CHINA Motor Bus Company has just finished building its first bus in seven years.

"It took my men only five weeks to make the body," CMB traffic manager E.L. Rees revealed today.

"And we usually wait two years when we order one from Britain.

"We are hoping to build some more in our workshops soon.

The double-decker tops are converted from old

single-decker bodies.

"Although the capacity and size is the same as that of our other buses the locally-made one is more comfortable.

"Building the bodies here saves a lot of time and money."

Mr Rees would not disclose what the body cost to build — but it's much less than the \$120,000 paid for imported buses.

**WE CAN MAKE IT ...** and proving we can are the CMB's bus-builders.





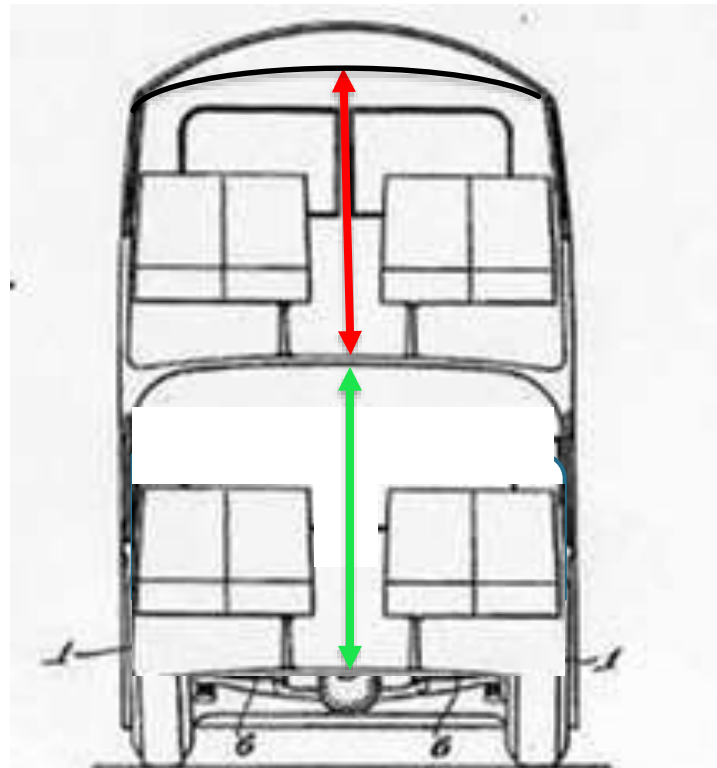
S Type Overall Height - 14 ft. 7 in.

***Mt Kellet Road Bridge headroom - 14 ft. 4 in.***

Government Regulations : Lower Deck headroom - 5 ft. 9 in.

Upper Deck headroom - 5 ft. 8 in.

LS Type Overall Height - 14 ft. 2 in.











Fleet No.	Upper Deck	Lower Deck
S1	New Metsec M24 body with small fixed glass bay	
S2 - S3	New Metsec M43/M44 bodies without small fixed glass bay	
S4 - S9	Original Metsec SD body	CMB scratchbuilt
S10 - S40	Original Metsec SD body	Metsec S kit (31 sets)
S41 - S49	Original Metsec SD body	Metsec S kit
LS1 - LS19	Original Metsec SD body	Metsec S kit (19 sets)







# Long Dragon Conversion to Double Decker

## Long Dragon

- ▶ 35 ft. 9 in. long
- ▶ 22 ft. wheelbase
- ▶ 34 seats
- ▶ 56 standees
- ▶ 76 ft. turning circle
- ▶ 80 ft. swept circle

## LX Double Decker

- ▶ 31 ft. long
- ▶ 18 ft. 6 in. wheelbase
- ▶ 70 - 78 seats
- ▶ 13 - 18 standees
- ▶ 60 ft. turning circle













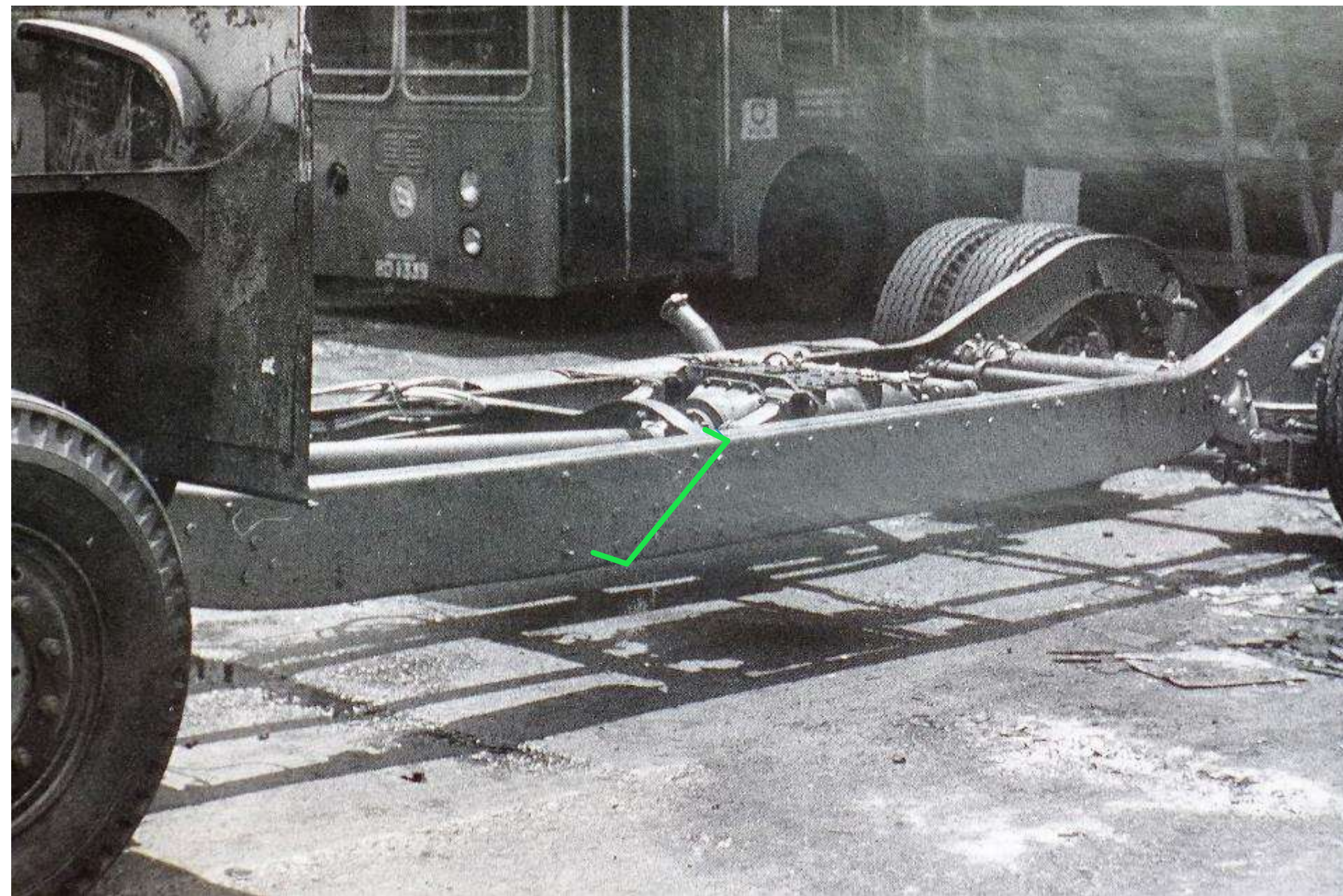
MACHINE



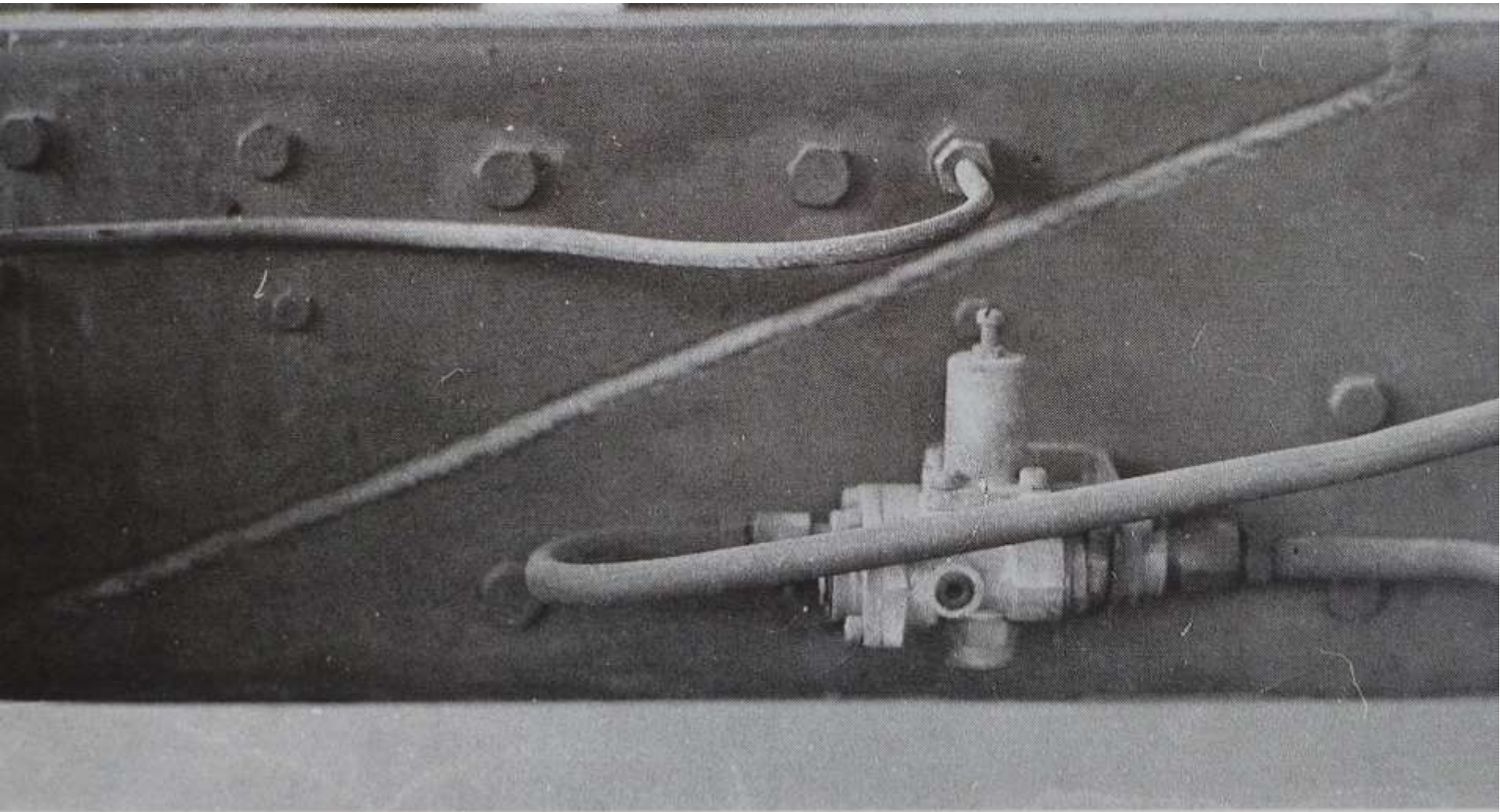


As well as being cleaned  
inside and out, the  
underside of a bus must  
be cleaned on a regular  
basis. The build-up of  
dirt, oil and grease is  
removed using steam.  
Once the dirt is removed,  
checks can be made for  
any damage or faults  
which are then repaired.



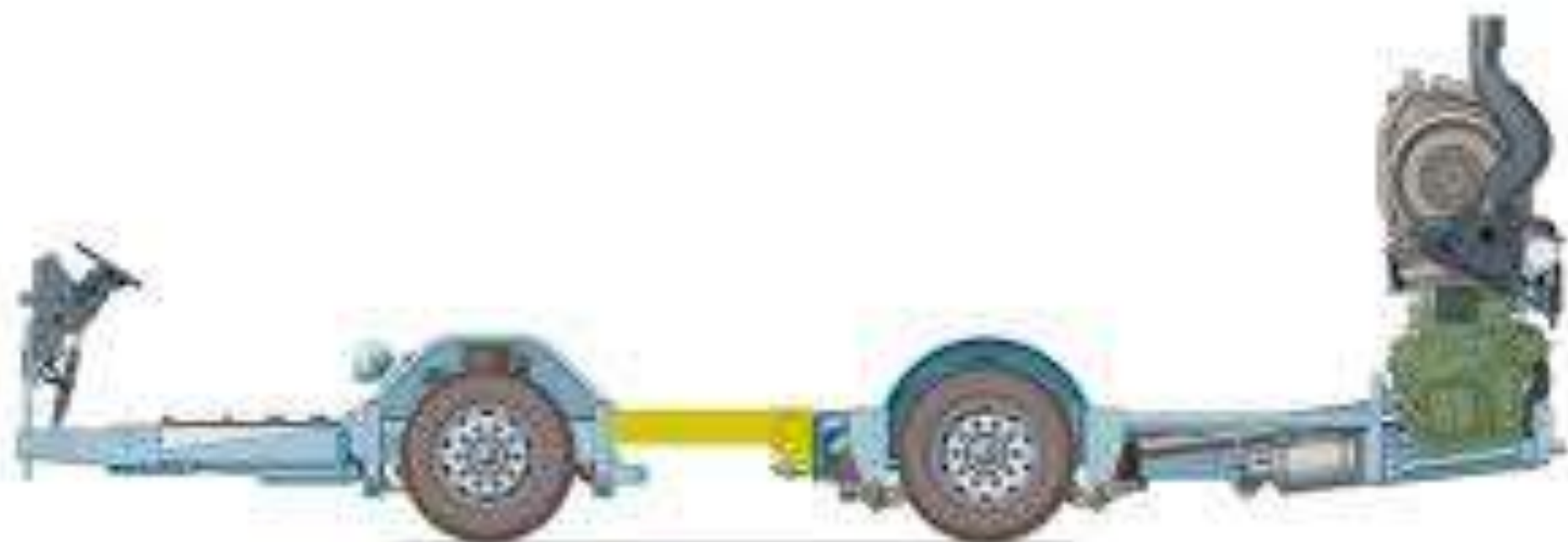












Nottingham City Transport has once again selected Scania chassis in an order for 40 N 230 UD4x2 units, to be equipped with Alexander Dennis Limited (ADL) E4005 full height double-deck bodywork.

Scania (Great Britain) Limited  
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March 2013



















































# 40 Long Dragons Converted to Double Deckers

BODY TYPE	Wong Chow Type I	Ex U K Body	British Aluminium	Wong Chow Type II
1971	3			
1972	2	6		
1973		6		
1974		6		
1975			15	
1976				2
Total	5	18	15	2

# Long Dragon with Yong Chow Body

971	3
972	2
975	--
976	2





# Long Dragon with UK Body

1972

6

1973

6

1977

6





# *LX With British Aluminium Body*

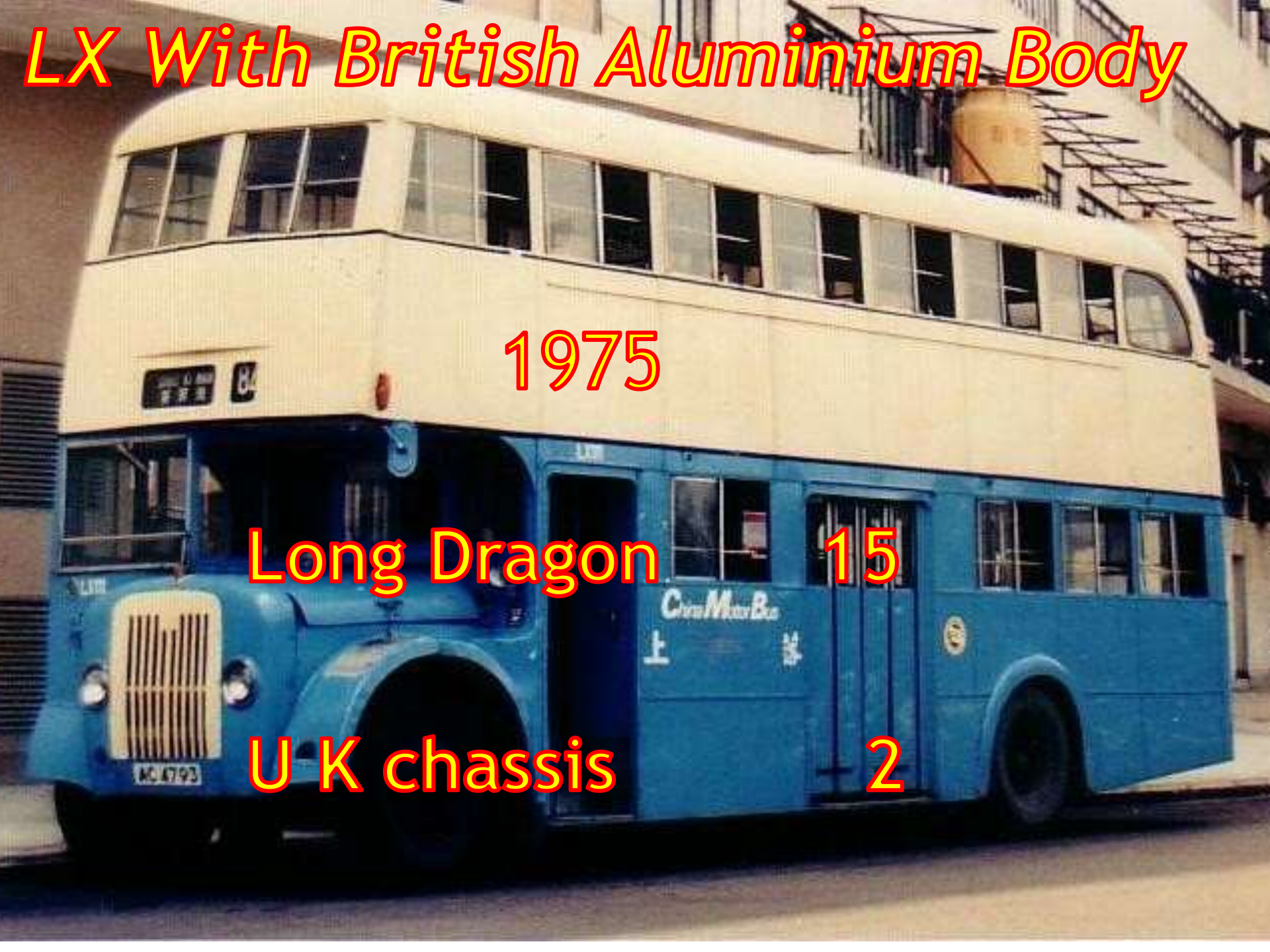
1975

Long Dragon

15

U K chassis

2





# Wong Chow Body on Ex West Midlands chassis

1975

6

1976

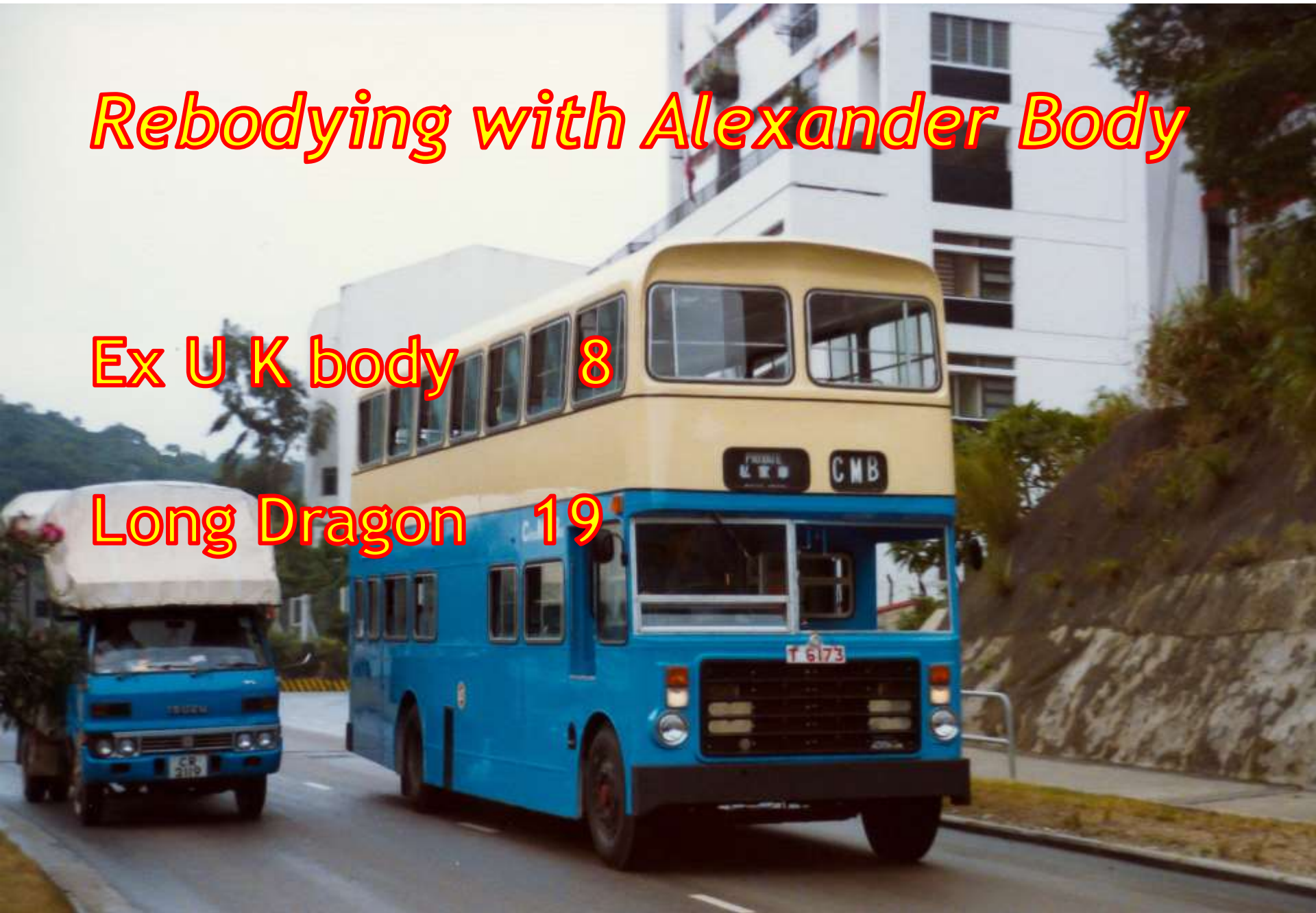
2



# *Rebodying with Alexander Body*

Ex U K body 8

Long Dragon 19





# 什麼

## 是十進制？

這是一種度量衡的制度，最常用的單位如下：  
以「米」為長度單位，以「千克」為重量單位，以「升」  
為液體容積單位。

本港已有那些單位改用十進制？

有關溫度和運動項目所用的單位，便是最佳例子。我們現已改用攝氏度數記錄溫度，並且改用米計量賽跑、游泳和賽馬的距離，在改用期間並無困難。

本港現有那些度量衡單位已着手改用或  
行將改用十進制？

各類計算，遲早都會改用十進制單位。基本例子如下：

食品——所有食品將以千克或克計量，其中若干食品，如奶粉及罐頭食品，現已採用此等單位計算。

飲品——所有飲品將以升或毫升計量，正如目前許多葡萄酒、烈酒和不含酒精飲品所用的一樣。

衣物——購買布料將以米計量，裁縫度身亦將採用厘米。

米(m)是計量長度的基本單位，但「長度」亦指高度、闊度、深度及距離。  
千米(km)用以計量較長的距離，如道路等(1千米=1000米)，但一座山的高度，  
則以米計量。

厘米(cm)主要用以量度身材及衣物(1米=100厘米)。

圖中巴士約4.4米高及10米長。隧道巴士駛過海底隧道，全程1.6千米；  
你用以支付車費的新壹圓硬幣，直徑有2.5厘米。

常用單位的換算大約如下：1吋=2.5厘米 1呎=0.3米 1哩=1.6千米



# Secondland from the U K

## *Considerations*

- ▶ Standardisation with existing fleet
- ▶ Staff training
- ▶ Spares availability
- ▶ Reliability & Performance
- ▶ Availability in the market
- ▶ Local adaptations



# Front Engined



Lancashire United Transport



Southdown



# Rear Engine



Western Welsh

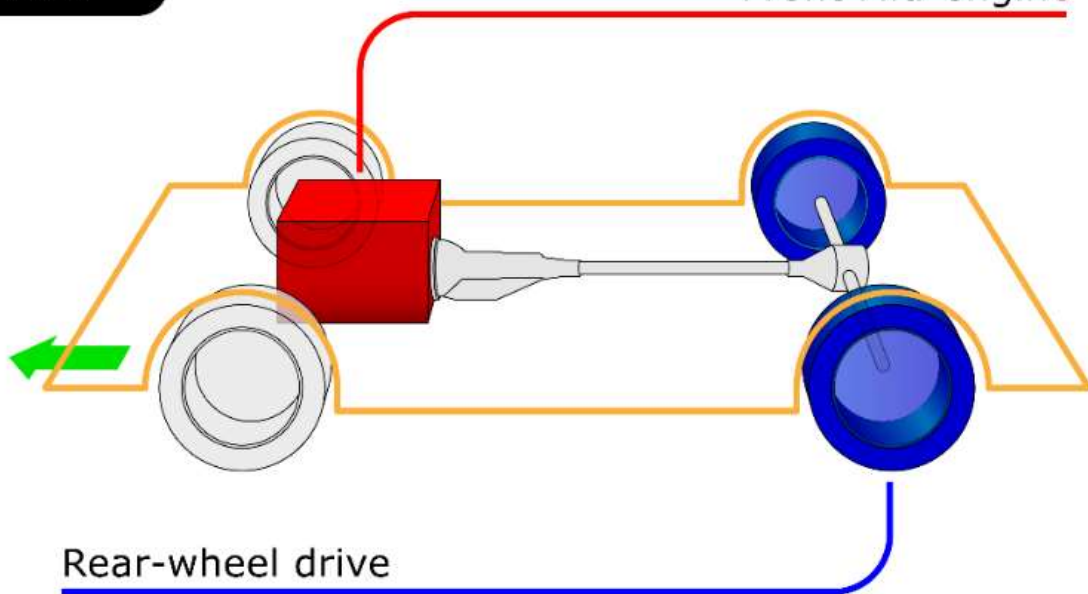


London Transport



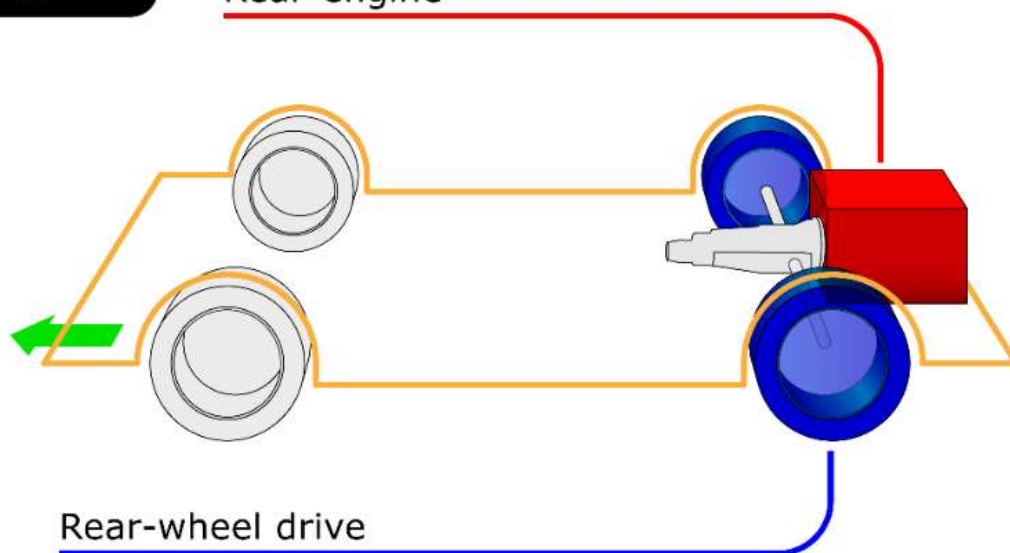
**FMR**

Front Mid-engine



**RR**

Rear-engine

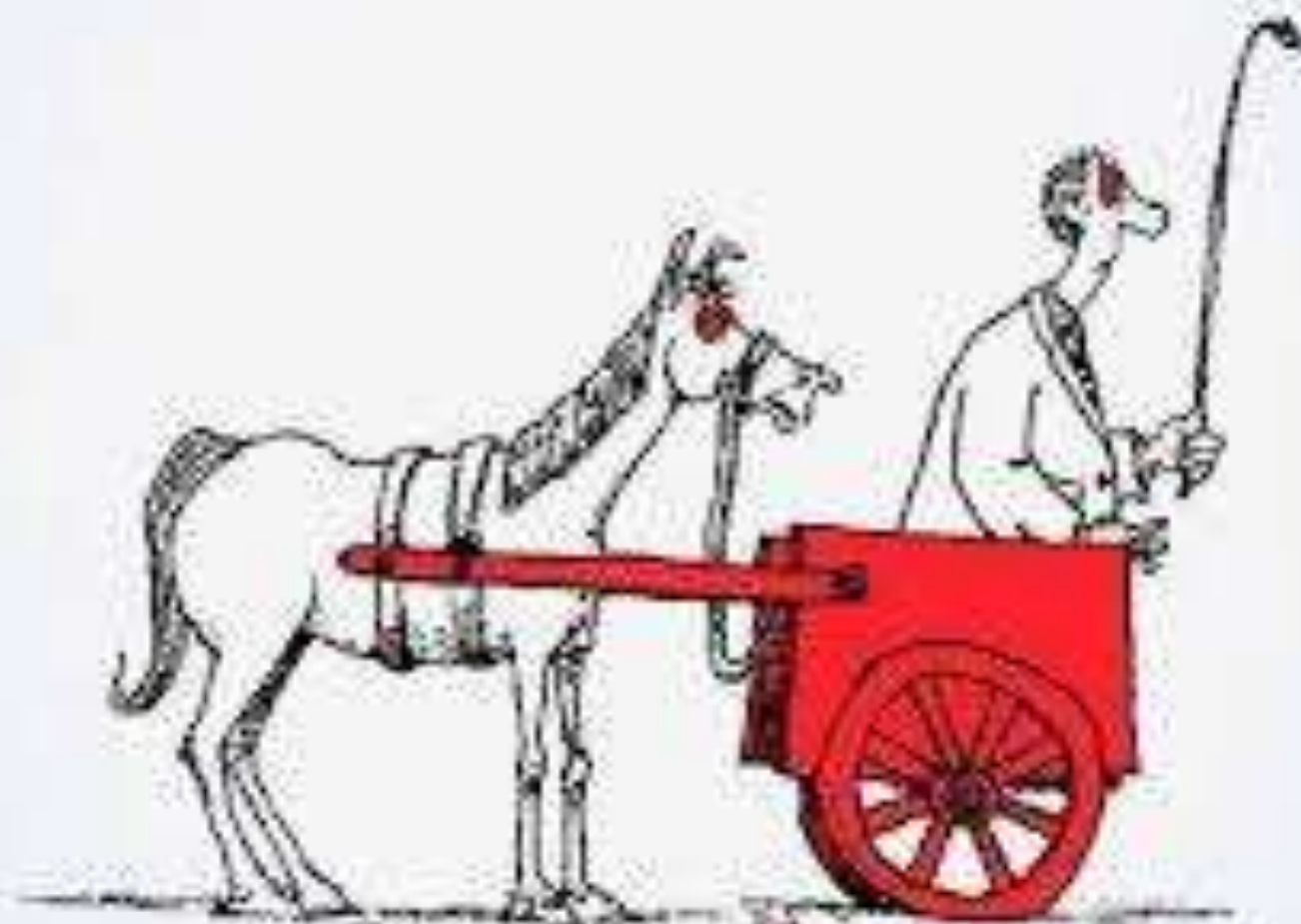






# **put the cart before the horse**

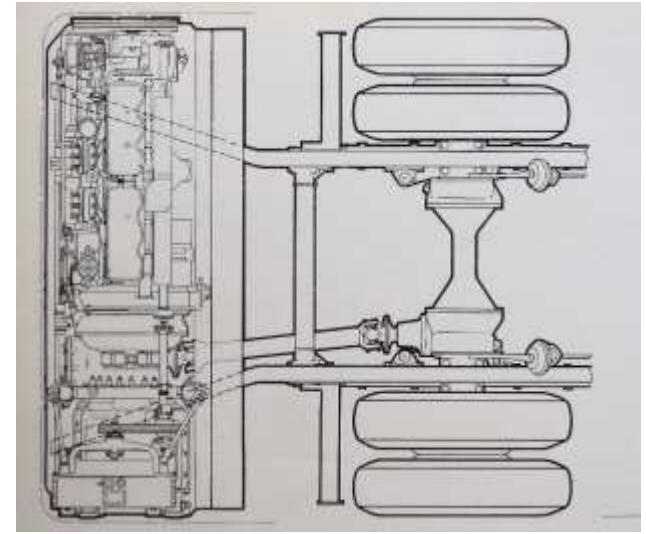
~ to do things in the wrong order, back to front ~



# Rear Engined Bus

## Weaknesses to Company

- ▶ Complicated angle drive design
- ▶ Long control cables and tubing to drivetrain
- ▶ Radiator overheating
- ▶ Inconvenient towing recovery
- ▶ Driver unaware of engine conditions





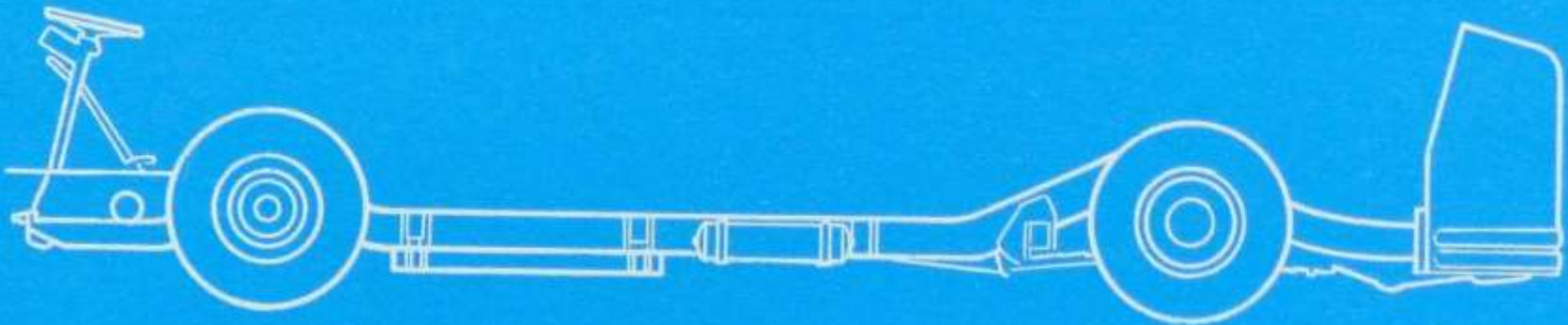
# Rear Engined Bus Weaknesses to Driver

- ▶ Long front overhang, bigger swept circle
- ▶ Driver unaware of engine conditions
- ▶ Poor frontal impact protection
- ▶ Weak protection from pax assault



# Rear Engined Bus Strength to Company

- ▶ Good engine gearbox access
- ▶ Lower CG with lower overturning risk
- ▶ Good axle load distribution with good steering





# Rear Engined Bus

## Strength to Passenger & Driver

- ▶ Low ground clearance - easy passenger entry exit
- ▶ Disabled passenger access feasible
- ▶ Good contact with passenger
- ▶ Facilitates One Man Operation
- ▶ Quiet & comfortable saloon
- ▶ Comfortable driving cab with good access



# 1972 - Daimler Fleetline SWB





# 1972 -Metro Scania Metropolitan



# 1973 - Daimler Fleetline LWB





# 1978 - M C W Mk I Coach



# 1978 - MCW Metrobus





# 1979 - Dennis Dominator



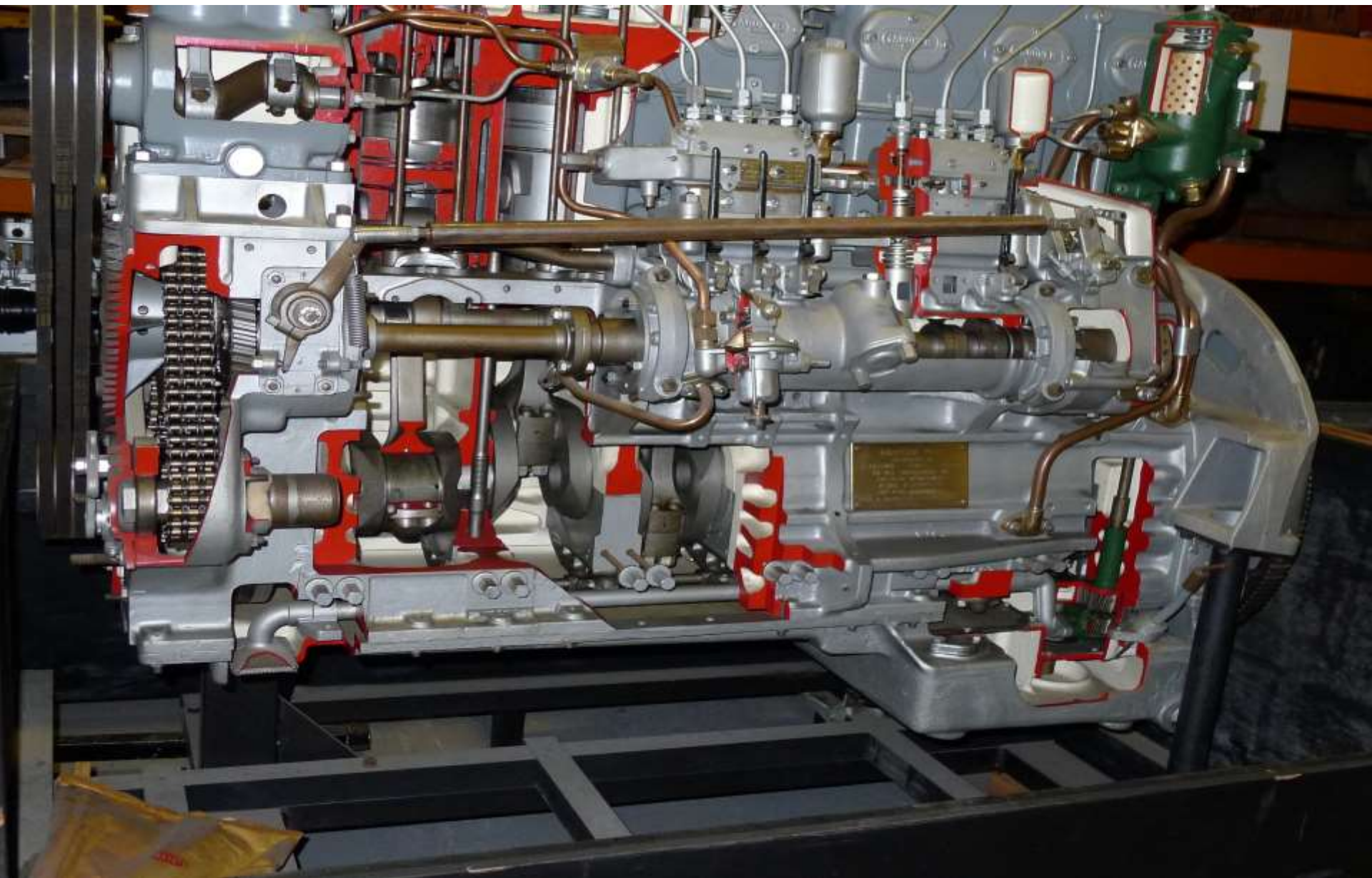
# 1980 - Leyland Titan









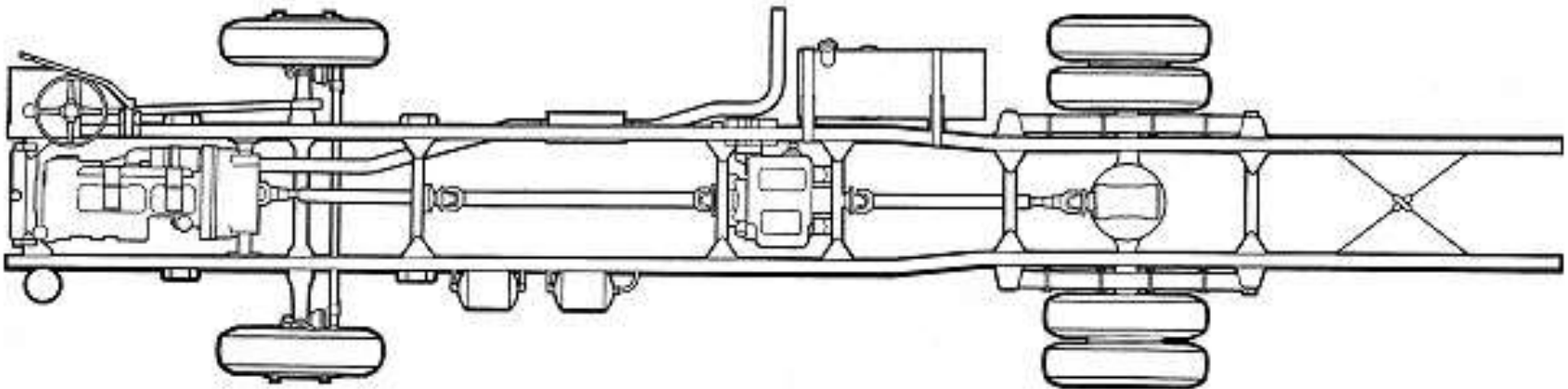




# Front Engined Buses

## Strength to Company

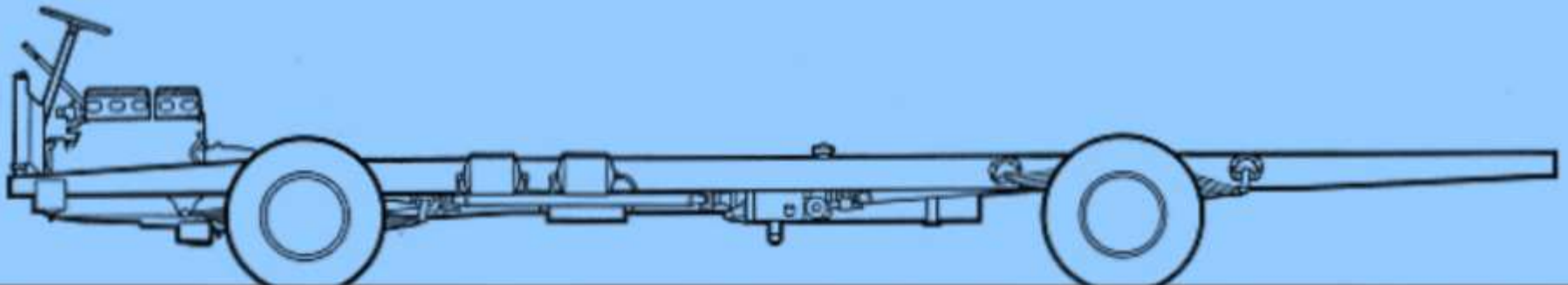
- ▶ Simple drivetrain design
- ▶ Short control cables and tubing to drivetrain
- ▶ Short front overhang, short swept circle
- ▶ Good engine cooling
- ▶ Easy towing recovery



# Front Engined Buses

## Strength to Driver

- ▶ Short front overhang, short swept circle
- ▶ Driver aware of engine conditions
- ▶ Good frontal impact protection





# 1972 - Ashok Leyland PD





# 1975 - Ailsa Volva SWB

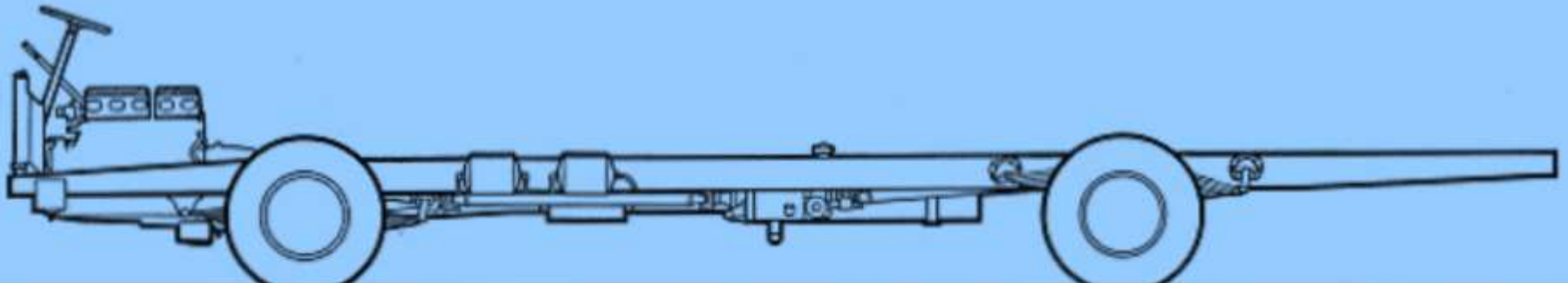




# Front Engine Bus

## Weaknesses to Company

- ▶ High CG - higher overturning risk
- ▶ Inconvenient engine/ gearbox access
- ▶ Impedes one man operation



# Front Engine Bus

## Weaknesses to Passenger and Driver

- ▶ High ground clearance - poor passenger entry exit
- ▶ Impedes one man operation
- ▶ Poor contact between passenger & driver
- ▶ Hot & noisy saloon
- ▶ poor cab access
- ▶ Heavy steering







乘客詢問熱線  
BUSINESS INQUIRY  
HOT LINE  
3-7454466  
10000

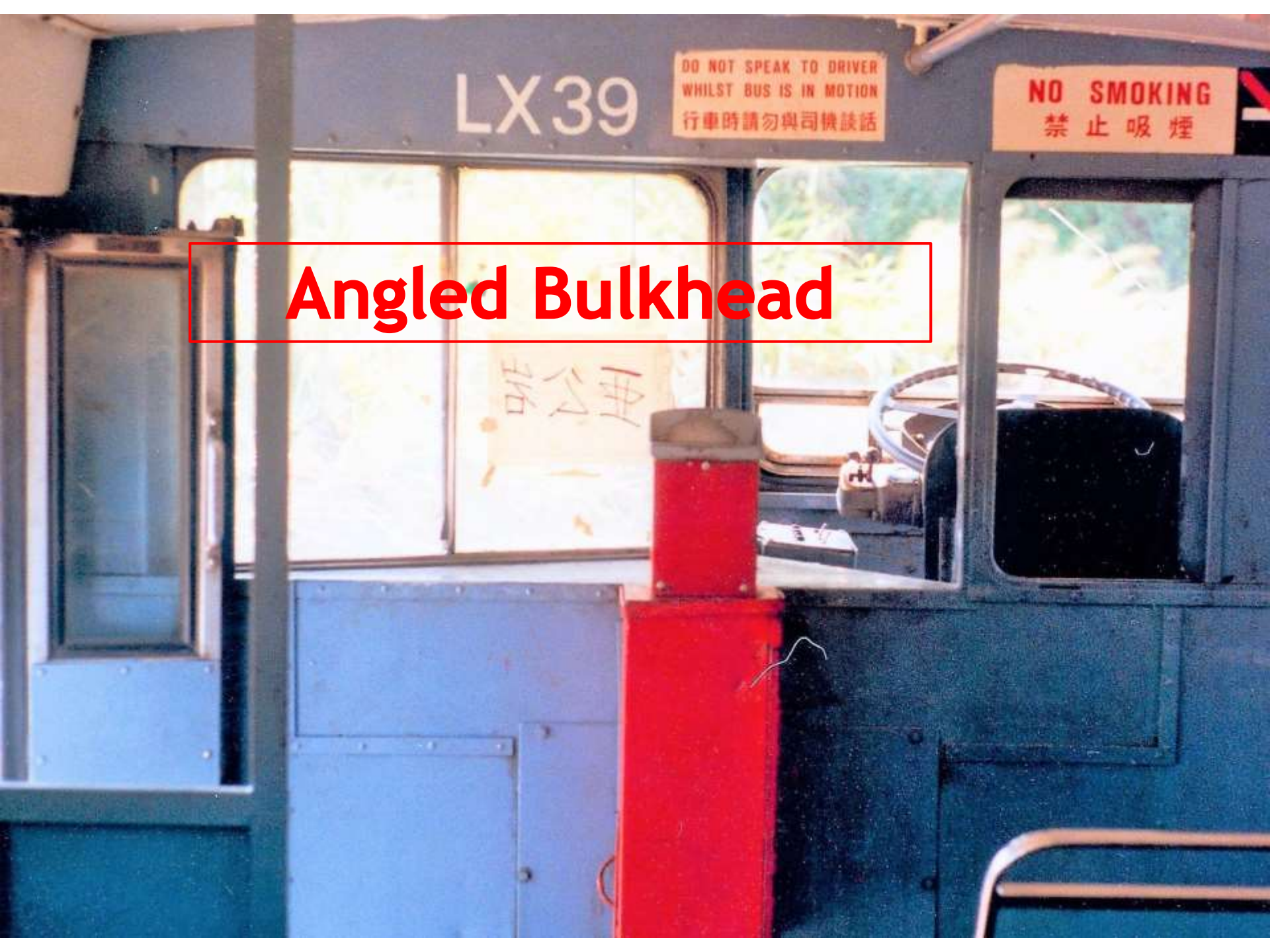
AD4748

LX39

DO NOT SPEAK TO DRIVER  
WHILST BUS IS IN MOTION  
行車時請勿與司機談話

NO SMOKING  
禁止吸煙

Angled Bulkhead





# Leyland Victory J



# Dennis Jubilant





# 1979 - Dennis Jubilent & Leyland Victory







# New Bus Development

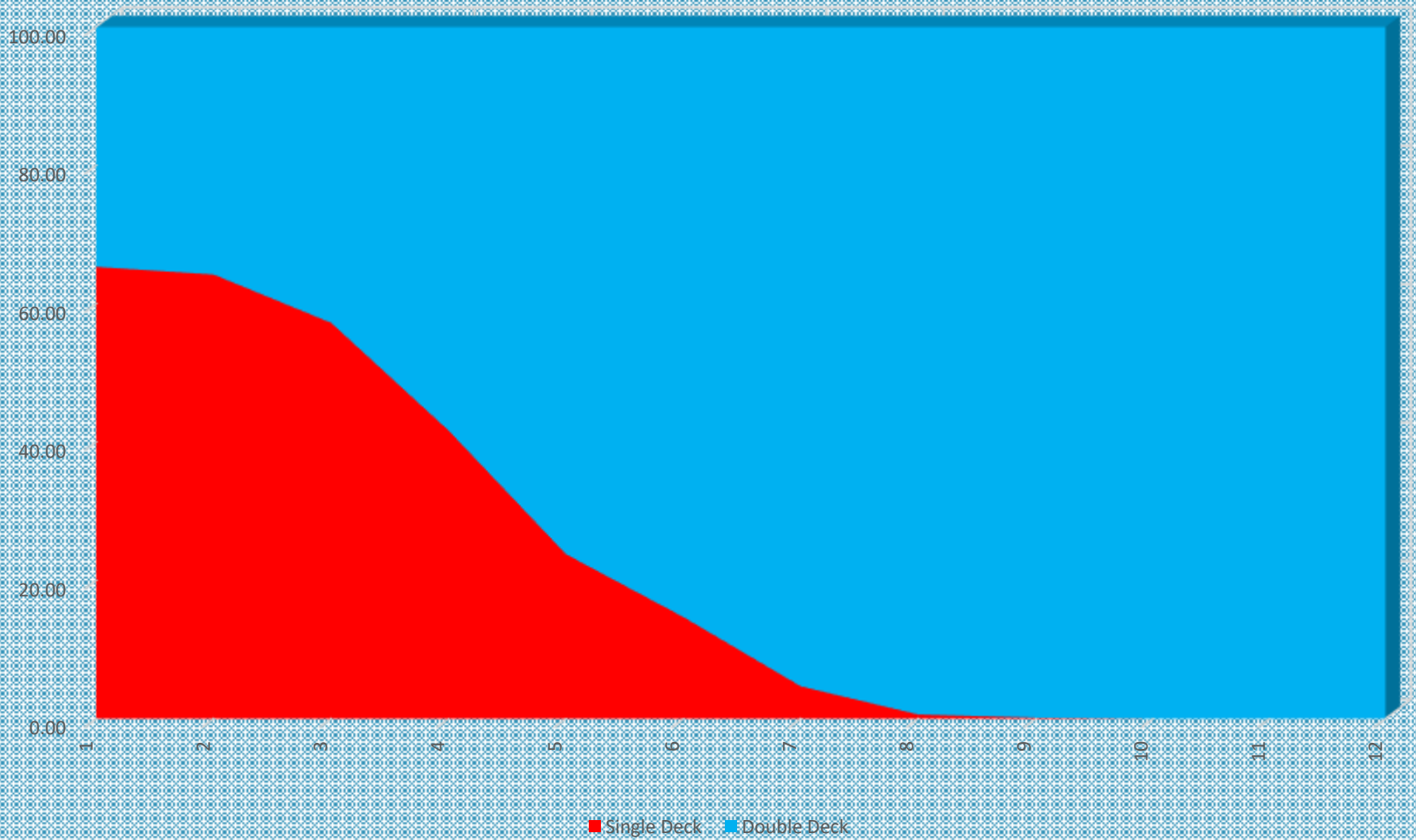
	Front Engine	Rear Engine	KMB Front Engine
1972	Q1 - SF1		
1973	Q4 - LF		
1974		Q2 - APD	Q2 - LF
1975	Q4 - AVS	Q4 - MS	
1976	Q4 - AVL		Q1 - G
1977			Q4 - N
1978		Q1 - MC Q4 - MB	
1979	Q4 - LV	Q1 - DD Q4 - SF	
1980	Q1 - DS	Q1 - TC	124

# New Bus Development

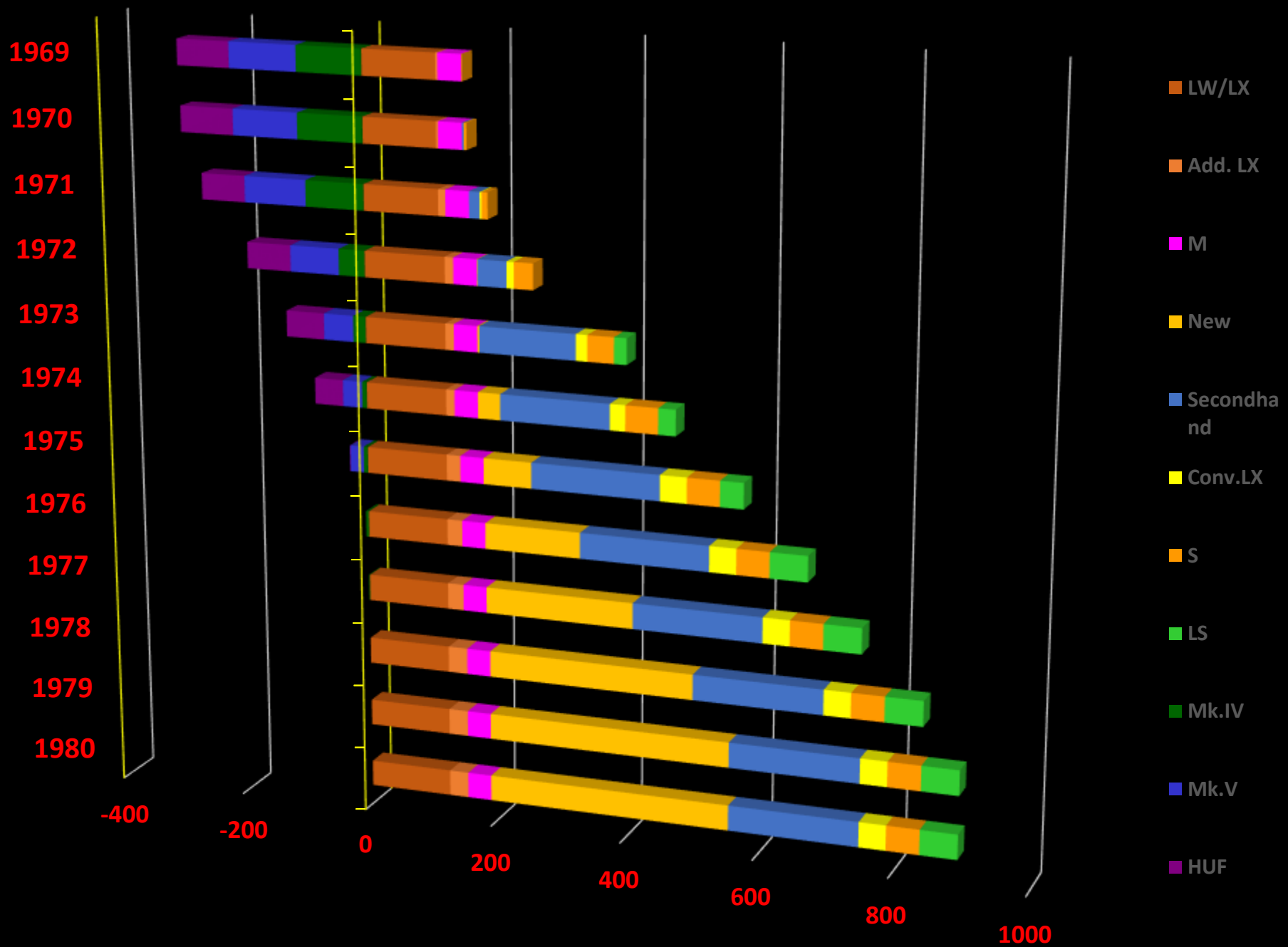
	Front Engine	Rear Engine	KMB Front Engine
1972	Q1 - SF1		
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1974		Q2 - APD	Q2 - LF
1975	Q4 - AVS	Q4 - MS	
1976	Q4 - AVL		Q1 - G
1977			Q4 - N
1978		Q1 - MC Q4 - MB	
1979	Q4 - LV	Q1 - DD Q4 - SF	
1980	Q1 - DS	Q1 - TC	



Single & Double Deck Percentage

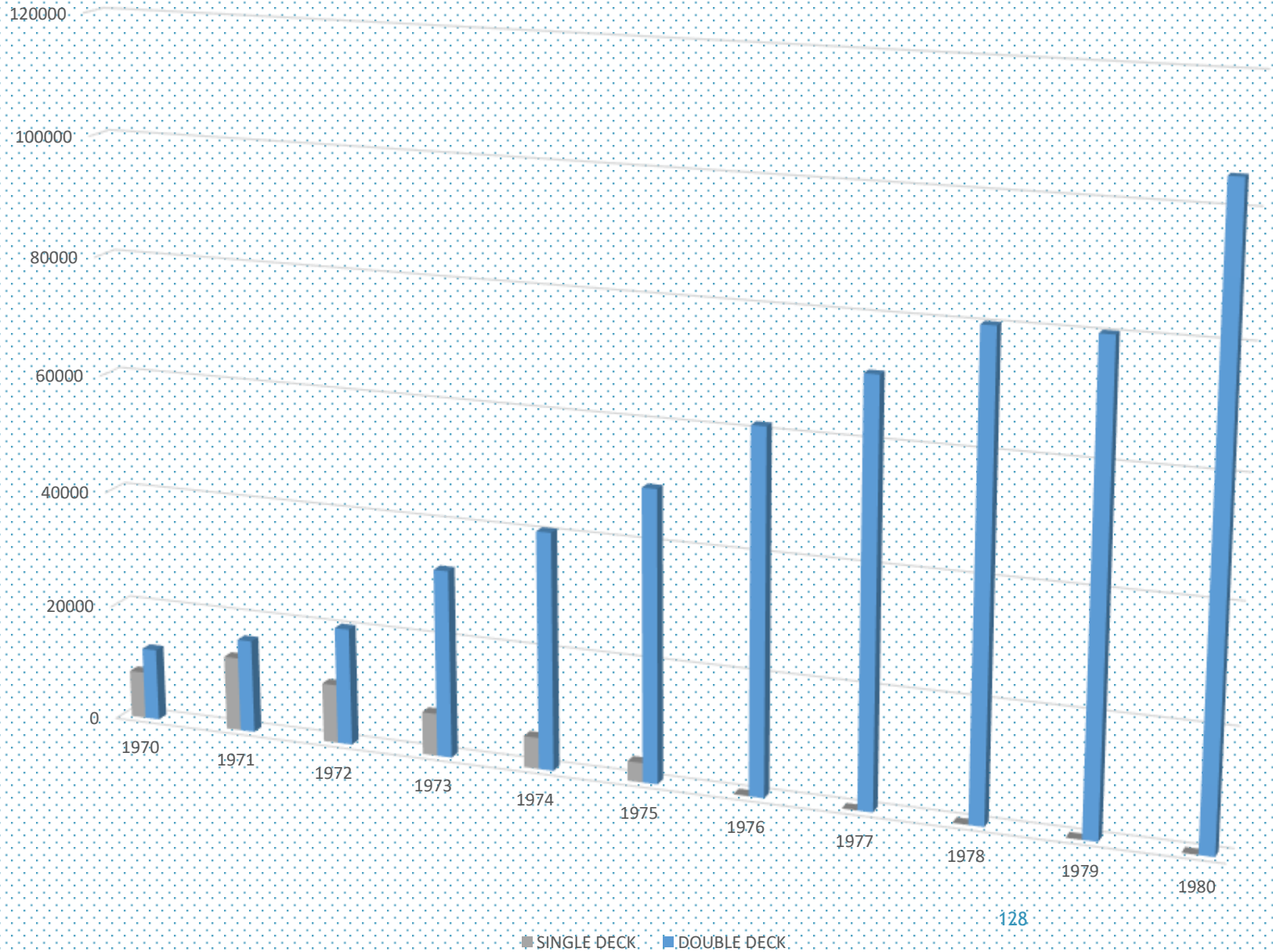


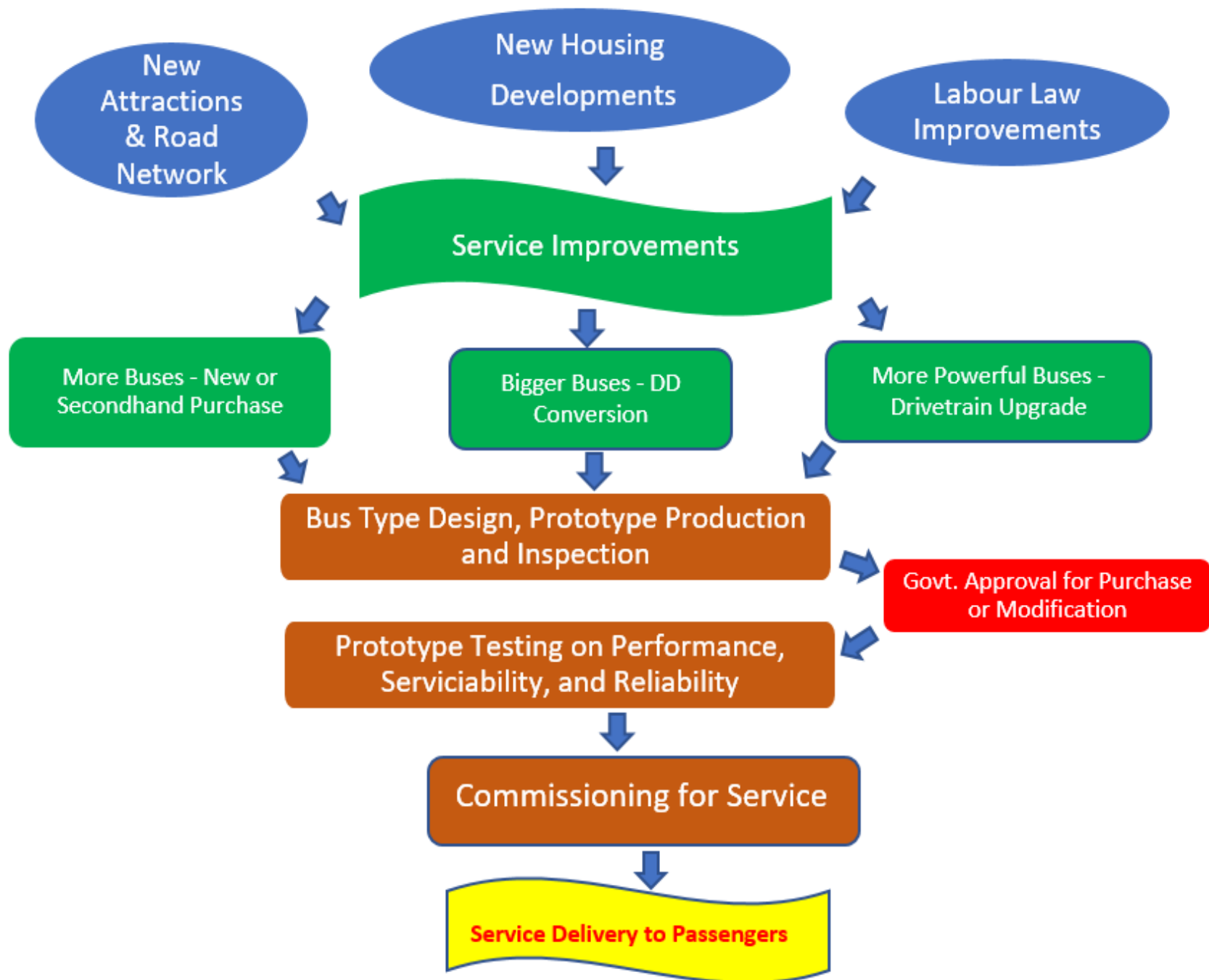
## Single/Double Deckers





## FLEET CARRYING CAPACITY









Questions and Answers



# Engineering Match in 70s

1970s was the era of growth for Hong Kong and the social advancements created unprecedented demand on public transport. When means of mass transit such as metro system was not yet in place, the heavy burden fell on buses and creative ways were devised to meet the surging needs. IMechE Hong Kong Branch reviews this chapter of history to appreciate how engineering played its part in offering solutions to make Hong Kong better in transport 40 years ago.



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*Free admission, 100 seats offered on first-come-first serve basis*

**Date:** 15 August 2017

**Time:** 19:00 to 20:30

**Venue:** PQ303, The Hong Kong Polytechnic University