Transport for London

Your ref: 442
Our ref: LD15/410

John Biggs AM
Chair of the Budget and Performance Committee
London Assembly
City Hall
The Queen's Walk
London
SE1 2AA

6 August 2015

Leon Daniels
Managing Director
Surface Transport

Transport for London
11th Floor, Zone R4
Palestra
197 Blackfriars Road
London SE1 8NJ

leondaniels@tfl.gov.uk

Dear JSL

Budget and Performance Committee meeting, 2 September 2015 – New Routemaster

Thank you for your letter of 1 July advising that the Budget and Performance Committee intends to use your 2 September meeting to examine our decision to develop and purchase New Routemaster buses.

Your letter requested specific information regarding the New Routemaster project, which I have enclosed.

Although we have released a lot of information around the New Routemaster, we haven't released the business case in full previously. In the interests of openness and transparency, I am of course happy to provide you and the Committee with a copy as well as the full appendices. You will note some of the information has been marked TfL restricted. I would be grateful if you would let me know if you or the Committee plan to circulate this information more widely as we may need to review some of the content if it is to be made publicly available.

I would also like to take this opportunity to make clear that the New Routemaster has achieved its objectives. We now have a modern state-of-the-art and iconic bus capable of meeting the needs of passengers in London. We are proud to have delivered the New Routemaster to schedule, under budget and in a very challenging economic climate.

The New Routemaster has led the way in driving up efficiency standards and left a legacy in which the bus manufacturers are now actively looking at how they can develop the hybrid bus market to make them even cleaner, greener and cheaper. Many lessons have been learnt along the way and without its development who knows how long this progressive change would have taken.

If you have any queries about the enclosed documents, please let me know. Otherwise, I look forward to the Committee meeting on 2 September, along with my Director of Buses, Mike Weston.

Yours sincerely

Leon Daniels
Managing Director – Surface Transport

Enc.

VAT number 756 2769 90

This page is intentionally left blank

New Routemaster information requested by John Biggs, Chair of the GLA's Budget and Performance Committee, in his letter of 1 July.

1. ***The Business Case and documentation in support of each decision made by TfL to invest in the New Routemaster including:-***

- **The design and development of a New Routemaster bus;**
- **The production of five prototype New Routemaster buses;**
- **The purchase of 600 New Routemaster buses in 2012; and**
- **The purchase of an additional 200 New Routemaster buses in 2014.**

When the first New Routemaster entered service in 2012 there was no other hybrid double-deck bus remotely close to its low emissions, fuel efficiency and operational flexibility. It was initially developed to meet the engine emission standard for Euro V in 2010 but was so far in advance of this for oxides of nitrogen (NOx) that it came closer to meeting Euro VI – a benchmark that had not been set at the time and would subsequently start to be introduced from 2014. There have been no comparably-low-emission hybrid buses with Euro V engines from that time and only the advent of Euro VI has enabled rival buses to catch up. In the meantime, London has benefitted from lower emissions and cleaner air

The project also spurred introduction of large numbers of low-emission hybrid vehicles to London as part of plans to tackle air quality with the most effective proven technologies available. London now accounts for around 1,350 vehicles– around half of those in the UK – compared to just 30 in 2009 and 56 in 2010 when they were relatively untried in London's demanding mass-transit high-frequency network involving 18-hour-a-day operation. The initial order helped accelerate this total to 266 in 2012 and, coupled with the contract variation to increase the initial order to 800, will move it swiftly to more than 1,700 in 2016.

It is a phenomenal achievement to have designed and built a new bus for London over such a short timeframe, and rolled out more than 500 production vehicles across 14 routes since 2009 with relatively few teething problems. Had the vehicle been developed at a slower pace, it benefits would have been eroded more quickly by the advent of Euro VI and cleaner conventional hybrids of the later engine generation. The recent battery and air cooling issues with the vehicle are minor compared to more fundamental structural faults with the original Routemaster bus and these are being addressed with Wrightbus.

TfL is on course to deliver 800 New Routemasters by 2016 as outlined in its latest Business Plan of December 2014 and as part of the Mayor's `2020 Vision' for 2,000 vehicles incorporating its design features. It has a contract with Wrightbus to build the first 1,000 vehicles to the same specification.

The business cases for purchasing 600 and a further 200 New Routemasters (NRMs) for London can be found in Appendix A. The benefit cost ratios are one element of the justifications and do not consider wider advantages such as generating jobs in manufacturing and light engineering across the UK.

The first 600 vehicles were purchased at a slightly higher capital unit cost than standard hybrid buses as they incorporated many non-standard features such as the arched back and open platform to reflect London's transport heritage.
On top of this were the boarding and alighting enhancements of two staircases and three doors and state-of-the-art hybrid technology. TfL, however, expects the vehicle to be commercially competitive over its whole life as initial higher capital costs will be offset by lower fuel consumption and its slightly longer working life. The 200 vehicles were negotiated at a lower price than the first 600, and incorporate the more expensive Euro VI engine and its exhaust after-treatment system.

The vehicle could have been designed as a solely open-platform vehicle with a second crew member on each bus supervising passengers. However, due to TfL's foresight that economic downturns could put pressure on operating costs, it was also designed to operate as a three-door bus with the platform closed, enabling some routes to operate for part of their operation or fully in one-person operation. In the current financial climate, this increases its commercial viability.

In operation, the vehicle continues to prove popular with the travelling public and achieves customer satisfaction scores that are three points higher (87 compared to 84) than conventional vehicles.

At the time the business cases were produced, it was not possible to gauge how the strategy for developing a new bus for London would drive forward design in the UK. The project's wider success has contributed to the emergence of much cleaner hybrids in the industry which are making use of lighter weight materials and achieving much lower emissions of NOx and particulate matter. Its iconic design and environmentally-friendly technology have also made it a centrepiece of the `GREAT' promotional tours organised by Department of Business, Innovation & Skills in Hong Kong, Singapore, New York and Abu Dhabi.

2. *Gateway review (Project Close Out) document for all completed New Routemaster programmes.*

We have provided the corporate Gate C and D review documents submitted to the Project Review Group (PRG) in July 2009 and December 2009. These considered the initial request for £0.5m to initiate the project and then £11.37m to proceed with the design, development and procurement of prototype vehicles. We have provided the close out review by Surface Board on March 12, 2013, which concluded the design and build project was complete with eight prototypes running successfully. It noted the project was generally well managed, that there were no critical issues and that it should pass through Gate D+ subject to a number of project best practice arrangements. We have also provided the independent assurance review for Surface Board on August 23, 2014, and its recommendations.

3. ***The review of the original business case, described in the New Routemaster Board paper on November 5, 2014, which compared the benefit cost ratio of NRMs to hybrids.***

   The review referred to above was not a document but background work conducted to update elements of the first business case. The case for purchasing 600 vehicles was based on New Routemasters replacing conventional diesel buses with Euro V engines, and assumed a proportion of buses with conductors. It also looked at one-off costs including development not applicable to an additional order.
   The additional order of 200 New Routemasters was approved within the existing commitment to have 1,700 hybrids of all types in service by 2016. The 2014 business case compared New Routemasters to conventional hybrids rather than diesel buses and the review was limited to the specific differences between the original and follow on order. The review:
   - Removed the one-off costs that were no longer relevant
   - Updated the figures relating to exhaust emissions including CO2 to compare to Euro V and Euro VI hybrid buses
   - Removed the figures related to conductor operation.

   It did not consider other elements of the earlier business case.

4. ***A breakdown of New Routemaster bus fleet by European emission compliance level, by age and by bus route as of April 2016.***

   The table in Appendix C shows the New Routemaster fleet with the confirmed allocations of engine type up to the end of 2015. As the 2016 roll out programme is linked to the contract tender process and yet to be commercially concluded, we cannot provide the route allocation beyond the end of the 2015 calendar year. However, we can say that 494 of the overall 800 will have Euro VI and 306 will have Euro V engines.

5. ***The number of New Routemaster buses that will be One-Person Operated from April 2016, when TfL has a fleet of 800 buses and the routes they will be used on.***

   The table in Appendix C shows routes that are normally in one or two-person operation on weekdays.

6. ***A breakdown of the capital and operational costs of purchasing and running a New Routemaster over its lifetime. Also provide figures on an equivalent basis for leasing an Alexander Dennis E400H or a Volvo BH5 over the same period.***

   TfL normally pays for buses through its route contract payments to operators, which includes driver pay, overheads and insurance as well as vehicle ownership, maintenance and fuel.

   Operators have a variety of ways of funding buses: some lease; others buy and depreciate; a few combine both forms of financing. The cost of buses within the

overall contract price not only reflects the initial price of the bus but also the costs of finance, depreciation policy, residual values and different levels of warranty and maintenance, all of which vary between operators and are commercially confidential. Therefore, as TfL does not directly own or lease conventional hybrid buses the most straightforward comparison is to compare the difference in overall contract price between New Routemasters and conventional hybrids for the same level of service specification.

On the routes where TfL has invited tenders on the basis of both New Routemasters and conventional hybrids, and awarded New Routemasters, the average annual cost saving per vehicle (across 199 vehicles) is £35,241 for New Routemasters. Taking into account the purchase price of the vehicles, the Net Present Value of New Routemasters over their estimated life of 14 years is similar to conventional hybrids. It also delivers higher levels of passenger satisfaction (as evidenced by the better customer satisfaction scores on converted routes).[1]

Comparison on routes where the introduction of New Routemasters has been negotiated during the contract life does not provide an accurate comparison, as the age of vehicles displaced varies and has led to other benefits such as the early removal of some of the oldest least clean buses from the fleet.

The contract to purchase 600 at a fixed price of £354,500 removed the risk of higher production and material costs. The vehicles were marginally higher in price than the estimated unit costs of conventional hybrids but were cleaner and more fuel-efficient than Euro V hybrids in the fleet. They have non-standard features including two staircases, a rounded rear sweep, three-door operation and an open platform which involve slightly higher build costs.

The capital cost of the eight prototypes was part of the design and build contract and are not separately itemised. The price of the 600 vehicles (buses nine to 608) was averaged at £354,500 regardless of delivery date or whether the engine was Euro V or VI compliant. As there was a delay to Euro VI introduction, a credit of £6,500 per bus that would have been Euro VI but was fitted with the Euro V engine, was given. The price of the subsequent 200 buses (buses 609 to 808) was negotiated at a reduced unit price of £349,500 even though all vehicles in this batch were to be fitted with the more expensive Euro VI engine.

Many components in the new bus including engine, chassis, superstructure and seats are manufactured in the UK. The initial production order for 600 followed by a further order for 200 has acted as an important stimulus for jobs and investment.

7. Bus emissions [NO2 (g/km), NOx (g/km) and PM10 (g/km) figures for the Euro VI compliant version of the New Routemaster following testing at Millbrook.

We have provided the emissions certificate of the New Routemaster with the Euro VI engine that was independently tested at Millbrook Proving Ground in Appendix D. This shows the vehicle remains the most fuel efficient and lowest CO2 hybrid in the

[1] *There are slight variances depending at route level and how the NRMs are depreciated.

fleet. It emits comparably low levels of oxides of nitrogen and particulate matter than the fleet average Euro VI hybrid bus. The test results will be published on the TfL website following the GLA Finance & Performance Committee meeting on September 2. The earlier version of the New Routemaster with Euro V engine emits a quarter of the oxides of nitrogen (NOx) of a standard Euro V hybrid bus, and in 2012 was already three quarters of the way to achieving the NOx standard for the Euro VI engine which started being introduced from 2014.

8. The results of studies carried out by TfL examining the relative fuel-efficiency of the New Routemaster buses compared to other types of bus.

TfL does not constantly monitor average fuel economy of each bus in the fleet including including New Routemasters due to the costs involved in collating such extensive amounts of data. Miles per gallon performance of a sample of routes converted to New Routemasters from conventional diesel vehicles has been published via the following link and is also included in Appendix E:

http://www.tfl.gov.uk/info-for/media/press-releases/2014/october/new-routemaster-buses-on-route-453

This shows average fuel consumption almost 50% better than the comparable conventional vehicles they replaced. This is an average figure for six routes monitored for one month periods in 2013 and 2014 during the conversion programme.

The number of buses that can default to diesel mode due to battery issues is a warranty matter that is being addressed directly by the manufacturer and is expected to be resolved shortly. This does not reflect general performance of the New Routemaster fleet so further fuel efficiency analysis does not represent a cost efficient use of resources.

Adoption of the ultra-low emission Euro VI engine is expected to lead to cuts in oxides of nitrogen (NOx) of up to 95% and particulate matter of up to 90% compared to an un-retrofitted Euro III bus. It will be independently tested under simulated route conditions to verify anticipated emissions reductions and fuel consumption.

9. Temperature analysis TfL has carried out in response to criticism of the hot conditions on the New Routemaster buses. Please explain how the issue is being dealt with on buses already in operation and buses on order as well as a summary of the number of complaints TfL has received related to this issue in each of the past three years.

Buses in the fleet are fitted with air cooling systems, not air conditioning. They work by providing cooled air and forced ventilation to the upper saloon of double deck buses in the fleet. The system aims to strike a balance between providing acceptable levels of comfort for passengers in normal summer conditions and minimising exhaust emissions from the fleet.

We routinely carry out checks on vehicles in service to assure ourselves that air cooling systems are working as designed on days forecast to have high temperatures. Our analysis of internal upper-deck temperatures on double deck buses in the fleet indicates the New Routemaster is no more susceptible to heat issues than other types of conventional buses and that improving passenger comfort is a network-wide rather than vehicle-specific issue.

Between late June and early July this year, 58 vehicles were inspected. The systems on 55 were working properly and three others found to be providing little cooled air output were referred to the operators for maintenance the same day. The checks also indicated slightly higher temperatures on some standard double deck buses than New Routemasters although the sample size was statistically small.
In-service checks were carried out the previous summer with similar outcomes. Systems were found to be working at capacity or adequately in the vast majority of cases, and only a fraction were not functioning as designed.

There is a public perception that New Routemaster vehicles feel less comfortable than buses with open windows. While the air cooling system works well in normal conditions it is, like other buses, at the maximum end of its output during heat waves. Passengers may regard journeys on buses with open windows more comfortable because of the air flow around them but this may actually result in warmer air entering and raising temperatures in the upper deck.

TfL recognises that more steps need to be taken to improve passenger comfort during high summer temperatures. A range of sustainable options is being considered to curb heat but these do not include air-conditioning units which would lead to much higher emissions from vehicles and prevent London addressing air quality issues such as the Mayor's objective to cut oxides of nitrogen from the bus fleet by 20% by 2015 compared to 2012 levels.

In the immediate term, we are trialling solar film on windows that can reduce the build up of heat by as much as 5°C under test conditions. Vehicles with and without the film are being fitted with heat sensors to record temperatures and indicate the effectiveness of this enhancement. The heat sensors are also part of a separate trial to help understand if this type of technology can help us monitor upper-saloon temperatures. If the equipment and data outputs prove reliable and productive, we will roll out more to the fleet. Sensors currently record information to a built-in memory which is then downloaded from the device and, therefore, is not live information that can be transmitted to a central collection point.

We have also reconfigured the air cooling system on New Routemasters to come on earlier by setting a lower thermostatic level of 21°C. This helps prevent heat build up and increases blown ventilation in the upper and lower saloon. This followed computer modelling work by London Underground's tube cooling team and the benchmarking of comparable air cooling systems on a range of double deck buses in a chamber heated to 30°C at Millbrook Proving Ground.

The Mayor has also asked TfL to work with Wrightbus to look again at possible design options to improve comfort across the fleet which, if successful, could result in New Routemasters on order and new conventional double-deck buses yet to be

procured incorporating new features. The options could include greater engine bay insulation and improved ventilation, and then looking at a revised solution and asking passengers to experience it to find out what they think.

Figures on passenger complaints about heat over the past three years are listed in the table below along with roll out numbers of New Routemasters in the fleet. The rate of heat complaints remains relatively stable over the three years in relation to the rapidly expanding number of buses in service.

On 1 July 2015, summer temperatures reached a record high of 37.4°C in London and put a strain on the public transport system generally.

Year	**No of NRMs in Fleet**	**Heat Complaints**	**Rate**
2015 to July	500	235	2.13
2014	260	156	1.66
2013	30	101	3.36