

## Programmes and Investment Committee



**Date:** 13 October 2017

**Item:** Elizabeth Line Operational Readiness and Integration

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### This paper will be considered in public

#### **1 Summary**

- 1.1 This paper updates on recent progress towards staged opening of the Elizabeth line as well as transition of the Crossrail Project to become an integral part of TfL.
- 1.2 A report on the proceedings of the Crossrail Sponsor Board is included elsewhere on the agenda for this meeting.

#### **2 Recommendation**

- 2.1 **The Committee is asked to note the paper.**

#### **3 Background**

- 3.1 Construction is being undertaken by Crossrail Limited (CRL), a wholly owned subsidiary of TfL, sponsored jointly by TfL and the Department for Transport.
- 3.2 Overall, construction is now 87 per cent complete. The major physical activities remain fitting out of stations, installation of the mechanical and electrical systems including cabling, overhead line electrification, ventilation, lifts and escalators, communications, power, signalling, and platform edge doors.
- 3.3 The project continues to have a strong health and safety performance although continued vigilance is being exercised as the nature of work changes from construction to a live railway testing environment.
- 3.4 The bringing into use of the central section infrastructure is a major integration activity. The next phases of the project are energisation of the railway followed by the start of dynamic testing – bringing a train into part of the tunnel for the first time – towards the end of 2017.
- 3.5 Key milestones are included in Appendix 1.
- 3.6 Work continues to incorporate the future Elizabeth line into TfL with an integrated customer proposition.
- 3.7 While costs continue to be closely managed as the project moves to its final stages, Crossrail remains within the available funding envelope of £14.8bn.
- 3.8 Further details on funding are contained in the report of Sponsor Board Proceedings (elsewhere on the agenda) and will also be reported to the Finance Committee.

## 4 Current Operations

- 4.1 TfL Rail (pre-Elizabeth line) services between Liverpool Street and Shenfield continue to operate with high reliability. In Period 6, the Public Performance Measure (PPM) was 94.0 per cent, below recent highs, principally due to a number of infrastructure failures but the Moving Annual Average (MAA) at 94.9 per cent is the second highest in the industry. In Q2 2017/8, Customer Satisfaction rose two points to eighty five, the highest level since the commencement of TfL Rail services in May 2015. The challenge going forward is to retain the high level of performance whilst introducing the new fleet of trains alongside the existing units and whilst Network Rail (NR) completes the rebuilding of the crucial tracks and sidings at Gidea Park.

## 5 Progress towards Phased Opening

- 5.1 The Elizabeth line opens in five stages through to December 2019.
- 5.2 **Stage 1** introduction of the first of the new Class 345 trains to run on existing tracks between Liverpool Street and Shenfield.
- 5.3 Customer reaction to the new Class 345 train continues to be very positive. Fourteen trains have been built and eight have now been accepted for passenger service, based at Ilford. Currently, three are in passenger service and two on driver training diagrams each day. The rate of introduction continues to be slightly behind programme due, principally, to issues with the commissioning of the platform elements of the Driver Only Operation (DOO) CCTV system. The outstanding issues are being resolved.
- 5.4 Lessons learned from the introduction of the new trains and infrastructure at Stage 1 have been captured and incorporated into planning for future stages, including closer monitoring of supplier programmes for software and assurance; clearer accountabilities and sign off for multi-party works; and strengthened management of integration by Stages as opposed to a focus on individual contracts.
- 5.5 **Stage 2** planned for May 2018 will provide four trains per hour between Paddington and Heathrow replacing the current two trains per hour Heathrow Connect service, operating to Terminals 2/3 and Terminal 4.
- 5.6 For Stage 2 the Class 345 train is being fitted by Bombardier to operate with European Train Control System (ETCS) signalling, as the tracks between Heathrow and Stockley (where trains join the current Great Western Main Line) will be fitted with this system. NR has completed installation and some testing of 'wayside' (track mounted) equipment which is supplied by Alstom but this then needs to be tested with the train.
- 5.7 A Class 345 train fitted with the necessary systems and software is underway at the Melton test track and the train is due to start testing in the Heathrow tunnels at the end of October 2017. A second period of testing is scheduled for January 2018. In addition, the wayside and train elements are due to be tested in a laboratory environment at Alstom's facility in Charleroi in October 2017. The additional 'lab' testing is particularly useful given the constraints on access to the

real operating environment at Heathrow, which is used by passenger services each day.

- 5.8 The development, integration and assurance of this complex, new, on train signalling system remains the most significant single risk to timely commencement of Stage 2 services, as successful completion of testing has to be followed swiftly by submission of assurance information to the approvals boards of the relevant operators and infrastructure managers as well as the Office and Rail and Road (ORR). Training of more than 60 drivers has also to follow train testing, although this is planned to be supported by the provision of a cab simulator, which will be moved from Ilford where it has been used to train drivers for Stage 1.
- 5.9 Stage 2 also requires work to the tracks and stations. There are significant platform works to be undertaken by NR, including some adjustment of platform heights, installation of the DOO CCTV system and the provision of turnback facilities at Hayes and Harlington Station. With the Great Western line simultaneously being upgraded for the Inter City Express Project (IEP) there are potential constraints on the ability to gain full access to the infrastructure at the times required for the Crossrail project. While NR believe it has time to complete the necessary works, there is little, if any, leeway.
- 5.10 At Heathrow, TfL, in conjunction with the airport, is fitting Oyster and Contactless ticketing facilities ready for the commencement of TfL Rail/Elizabeth line in May 2018. These will also be used to extend acceptance of Oyster and Contactless to Heathrow Express (HEX) services, although HEX will continue to charge separate fares.
- 5.11 The main depot for the Elizabeth line train fleet is at Old Oak Common. The maintenance building has been completed and testing and commissioning systems and equipment continues. The first section of the depot is planned to be brought into use at the end of November 2017, ready to receive the trains that will operate to and from Heathrow as well as the fleet that will be delivered for testing and operation of the central tunnel. The second and third sections of the depot are brought into use in January and May 2018. Ultimately the depot will have 33 sidings in addition to the nine tracks within the maintenance facility.
- 5.12 From December 2018 (**Stage 3**), passenger services will operate in the central tunnel, between Paddington (new underground platforms) and Abbey Wood, via the West End, City and Canary Wharf. From this date services will be referred to as the Elizabeth line.
- 5.13 The completion of the track throughout the tunnel was achieved on 14 September 2017 and marked with a ceremony at Whitechapel.
- 5.14 The next stage in bringing the central section into use is energisation of the infrastructure. The immediate focus of work to move to energisation is on completing power and overhead line installation, including the new high voltage National Grid connection at Pudding Mill Lane.
- 5.15 Following energisation is the start of 'dynamic testing' (operating one, and subsequently more, trains in the tunnel to sequentially test all of the infrastructure). The programme for energisation and dynamic testing was, wisely,

brought forward when Crossrail's programme plans were updated in April 2015. This allows more time for subsequent stages of testing, commissioning and integration. Dynamic testing is due to start in November 2017 on the south east leg of the railway, in the section between Abbey Wood and Canary Wharf.

- 5.16 Dynamic testing will be extended west to encompass the rest of the central section in spring 2018. Throughout dynamic testing the railway remains a construction site, separated from all operational networks and is controlled under special testing arrangements from the Railway Control Centre at Romford.
- 5.17 For Stage 3 the Class 345 train requires further development to incorporate Communications Based Train Control (CBTC) signalling, which is added to the two other systems that will already be fitted to the train: 'conventional' UK signalling for the surface sections of route; and ETCS for the Heathrow spur. The software for this stage builds on that necessary for Stage 2 and is due to start testing on the Melton test track at the end of October 2017. Given the critical nature of train systems, regular project meetings continue at all levels between Bombardier the project team and, ultimately, with the MD London Underground.
- 5.18 Dynamic testing will extend through until summer 2018, undertaking increasingly complex tests – whilst at times the infrastructure will be closed to testing so that outstanding work can take place to complete the infrastructure. At the end of Dynamic Testing, planned for the summer of 2018, the railway infrastructure is officially handed over to TfL who assume primary responsibility for safety and operations and complete 'trial running' (the final testing of capacity and performance of the infrastructure) using up to 22 trains.
- 5.19 The formal handover of the elements of the railway is a major task as it marks the change of status from a construction to an operational railway environment. It requires the project and its contractors to have assembled the necessary evidence that the railway is functional and safe to operate. TfL, in taking over the railway, needs to be satisfied that the operational and maintenance teams are fully trained and competent, and that comprehensive safety management systems are in place to underpin both the operation and maintenance of the complex new infrastructure. A number of formal approvals and regulatory steps are required, many of which have not been used previously on anything as large and complex as Crossrail.
- 5.20 Training of the operational and maintenance staff who will run the railway is already underway, starting with complex systems (signalling and communications) at the suppliers themselves. From January 2018 intensive training will take place at the Training and Underground Construction Academy which transferred to TfL in January 2017 and will also accommodate continued construction training activities and the Back Up Control Facility for the railway.
- 5.21 Between handover and opening in December 2018, TfL will undertake 'trial operations', gaining familiarity and bedding down the multiple systems and undertaking drills and staff familiarisation including extensive emergency exercises, as well as using the Class 345 trains in the tunnel environment and optimising the train and signalling systems to obtain the highest levels of reliability. In the final stages of trial operations the railway will run a 'shadow' timetabled service to confirm reliability prior to public opening.

- 5.22 In May 2019 (**Stage 4**) Shenfield to Liverpool Street services are connected into the peak central tunnel section to run as far as Paddington; at this point the service in the central tunnel increases from 15 to 24 trains per hour. This requires intensive use of the complicated transition between the surface and tunnel signalling systems at Stratford, where train will move from running on the normal suburban railway to automatic operation (drivers remain on board throughout) in the central tunnel section. It is planned to test this interface as part of dynamic testing in the first half of 2018 and then use it routinely to transfer trains between Ilford Depot and the central section through trial operations and Stage 3 running.
- 5.23 In order to operate the full number of trains, NR has also to complete its upgrading of the power supply on the Anglia route. A resolution also needs to be found to the bottleneck caused by poor condition and layout of the slow speed (5mph) exit from Ilford Depot, which inhibits the provision of the full Elizabeth line service.
- 5.24 In December 2019 services from the West are connected into the central tunnel and Elizabeth line trains are extended in the West to Maidenhead and Reading. This is the final phase (**Stage 5**) of Elizabeth line service introduction and includes the additional services, west of Paddington agreed by the Board in March 2017. In the West, NR is currently in the process of tendering a number of station rebuilding works and is planning to complete the upgrade and rebuilding of stations in the West by the time Stage 5 opens in December 2019.
- 5.25 As Elizabeth line services share the tracks with other operators' services, final work on the detail of the full December 2019 timetable continues, including joint performance modelling with NR to demonstrate that the railway can achieve its target performance of 95 per cent PPM.

## **6 Crossrail Transition and Integration Programme**

- 6.1 As the project moves towards completion regular reporting on operational readiness is being provided to the Mayor. A pan-TfL/CRL, Elizabeth line Readiness Board has also been convened, chaired by the Commissioner, has commenced. In addition, a joint Crossrail/TfL Communications Board has been established to ensure a smooth transfer of stakeholder relations and to plan launch activities. The final Crossrail 'Open House' events took place in September 2017 when over 1,700 visits were made to four Crossrail stations – Farringdon, Liverpool Street, Whitechapel and the Canary Wharf.
- 6.2 Plans are in place to integrate the Elizabeth line into TfL's signage and wayfinding, customer contact and social media activities, as well as extending digital information screens which have been trialled at Ilford. The roll out of the Elizabeth line to joint stations will build on the successful 'One Liverpool Street' and 'One Stratford' work undertaken when TfL Rail first started operating, bringing together multiple operators at a location to focus on providing a seamless customer experience.
- 6.3 The Elizabeth line will make extensive use of the new TfL ticket machines with wider functionality and the ability to retail a full range of national rail, as well as TfL tickets.

- 6.4 Whilst the Crossrail Project has responsibility for providing the end to end railway including Stages 4 and 5 through to 2019, much of the work of CRL will be over by the second half of 2018, when handover of the central tunnel section is planned to have been completed and CRL will shrink in size and transfer certain activities to TfL. The Business Planning round currently underway will be used to ensure that the Crossrail and TfL plans match up, although the final stages of Crossrail are subject to a degree of uncertainty as to when specific activities, such as testing and commissioning, conclude.
- 6.5 Opportunities, including secondments continue to provide the opportunity for the transfer of expertise into TfL and closer working with Crossrail 2 and the new TfL Major Projects directorate is a key focus, to the benefit of all parties. A number of workshops have taken place to ensure that learning from Crossrail is captured in the developing plans for Crossrail 2 and the TfL Engineering activities for both projects now report to a single individual.

## **7 Conclusion**

- 7.1 Whilst there is a very significant amount of work still to complete and challenges that are to be expected with a project of this magnitude, the Elizabeth line continues to be on course to open, as planned and within funding, in stages through to December 2019.

### **List of appendices to this report:**

Appendix 1: Key Milestones towards Elizabeth line Opening

Appendix 2: Photographs of Construction Activities

### **List of Background Papers:**

None

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**Key Milestones towards Elizabeth line Opening**

Completion of end-to-end track in tunnel	September 2017
Complete Final Design Overviews	Autumn 2017
Energisation and Start of Dynamic Testing	Autumn 2017
Bringing into use of Old Oak Common Depot	November 2017
Network Rail Signalling Data Change (Paddington-Maidenhead) including interfaces to central tunnels and Old Oak Common Depot	Christmas 2017
Stage 2 commencement of services to Heathrow	May 2018
Trial Running – capacity and performance testing	Summer 2018
TfL takes over infrastructure and commences Trial Operations	Summer 2018
Stage 3 Opening of Central Operating Section	December 2018
Stage 4 Opening (Shenfield/Abbey Wood – Paddington)	May 2019
Stage 5 Opening (Shenfield/Abbey Wood-Heathrow/Reading)	December 2019

Class 345





**Romford Route Control Centre**



**Old Oak Common Depot**



Crossrail Tunnel



**CROSSRAIL IS LIVE**

- Power supplies are being switched on and all systems must be considered **LIVE** and **DANGEROUS**
- Comply with Site Electrical Safety Rules
- Follow the Golden Rules and if you are unsure, stop and ask

Look out for **STEPPING UP TO ENERGISATION** events  
**27 Sept | 31 Oct**

MOVING HEALTH AND SAFETY FORWARD

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