



◀ **BEST PRACTICE GUIDE** **CONSTRUCTION RAILWAYS** **OPERATIONS**



MOVING LONDON FORWARD

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Introduction

Preface

A fundamental element of the Crossrail project is the construction of a number of tunnels under London; eight of these tunnels are being created using tunnel boring machines (TBMs) which are used to bore the tunnels and place concrete lining segments. Each of these tunnels is served by a construction railway which is used to transport personnel, equipment and materials into and out of the tunnel.

Each of the construction railways is operated differently with the result that identified best practice tends to be limited to single sites. This Guide has brought together these best practices to ensure that construction railways are operated equally safely across all Crossrail sites.

This Best Practice Guide was produced as a result of collaboration between representatives from Crossrail and the three main tunnelling contractors engaged in TBM activities – BFK (C300), DSJV (C305) and HMJV (C310). Thanks are due to all those involved in the preparation, review and issue of this Guide.

Purpose

A construction railway is defined as a temporary railway that is used on tunnelling worksites and is exclusively for the purposes of moving construction related personnel, equipment and materials only. A construction railway is not considered to be an 'operational' railway because it is not a part of the UK railway network.

The Railway and Other Guided Transport Systems (Safety) Regulations (ROGS) do not apply to a construction railway, although relevant sections should be considered as a 'best practice' guide. However, PUWER and CDM Part 4 both apply to construction railways.

This Best Practice Guide details best practice standards specific to the movement of vehicles on a construction railway. This guide will help to optimise safe operation whilst at the same time maintaining efficiency and productivity.

This Best Practice Guide suggests minimum requirements for the safe operation of the construction railway; local arrangements should meet (or exceed) these requirements.

This Best Practice Guide applies to all personnel with an involvement in the movement of trains on the construction railway.

This Best Practice Guide should be used alongside:

- ◀ BS EN 1889-2:2003 – Machines for underground mines – Mobile machines working underground – Safety (Part 2: Rail Locomotives)
- ◀ BS 6164:2011 – Code of practice for health and safety in tunnelling in the construction industry (in particular Section 23)
- ◀ Local rules, procedures and processes governing safe operation of the construction railway



Part A – Tunnel Vehicle Movements

Section A1

Train Duties

Train duties (inbye)

Inbye trains will supply the tunnel and TBM with a number of items including (but not limited to):

- ◀ Operatives - transported on the man rider only
- ◀ Emergency Response teams (when required)
- ◀ Grout / concrete - which is carried in purpose built vehicles
- ◀ Temporary materials - pipes, brackets, walkway, oils, greases, soil conditioning agents
- ◀ Electrical equipment and miscellaneous items of small plant - transported on a flat car in a purpose built stillage
- ◀ Tunnel lining segments - carried by purpose designed segment cars

Train duties (outbye)

Outbye trains will:

- ◀ Provide egress for operatives by way of the man rider
- ◀ Carry maintenance equipment, rubbish, empty drums and other waste materials out in purpose built stillages on flat cars
- ◀ When transporting compressed gas bottles (e.g. propane, fuel gas) use a protective steel enclosure, mounted on a flat car and under a Permit to Work (PTW)

- ◀ Haul out empty cars

Typical train configuration - tunnel working

A typical train configuration might include:

- ◀ Segment cars/bogies
- ◀ Grout / concrete car
- ◀ Standard flat car for transporting temporary materials
- ◀ Manrider
- ◀ Locomotive

Variations in the train composition may be required during service periods (e.g. cherry-picker, HIAB crane etc.).

Each locomotive will be known as (and controlled by) a specific individual designation (which will be marked on each locomotive) in the following format:

Locomotive + "Number" i.e. "Locomotive 1"

Should a locomotive be required to service either tunnel or switch from westbound to eastbound, a locomotive designation shall be assigned to avoid any confusion between the Operations Board Controller (OBC) and driver.

A driver will be assigned to each locomotive on a shift by shift basis.

Section A2

Roles and Competencies

The Locomotive Driver shall:

- ◀ Be responsible for ensuring that all loads are properly secured before a loco movement is commenced (both inbye and outbye)
- ◀ Be responsible for ensuring that identified defects are entered in the Daily Loco Checklist
- ◀ Hold appropriate certification such as CPCS Certification (A67 Tunnel Locomotive, Diesel, Category D, all sizes) or equivalent
- ◀ Have received a minimum of 30 hours familiarisation training in accordance with local arrangements and have been assessed as competent
- ◀ Successfully complete Crossrail Tunnel Safety Card (TSC) training
- ◀ Attend local Tunnel Induction training and be trained in the requirements of this Best Practice Guide
- ◀ Be appointed as a Locomotive Driver in writing by site management; records of this are to be held on site in accordance with BS6164:2011 (23.1.1)
- ◀ Be fully briefed and conversant with all relevant local procedures
- ◀ Be aware of track walking procedures, persons walking on the track, persons working on the track, track possessions etc
- ◀ Check points are fully (and correctly) engaged before entering any crossings
- ◀ Ensure that when propelling (breasting) the train into the tunnel, this is carried out in accordance with BS 6164: 2011 (Section 23.1.3) - the driver must have sufficient visibility of the track ahead to be able to stop within his field of view
- ◀ Be trained in the use of derailleurs, wheel blockers, Manchester gates etc
- ◀ Be trained in the use of communications systems and all relevant procedures and protocols
- ◀ Be trained in the use of fire extinguishers and relevant fire fighting equipment
- ◀ Be trained in the application of this Best Practice Guide. This training will be supported by refresher training and any other briefings as deemed appropriate by local management



Operations Board Controller (OBC)

The Operations Board Controller shall:

- ◀ Be responsible for the management of all railway movements
- ◀ Have been assessed as competent to carry out all activities associated with the role
- ◀ Be responsible for maintaining a record of all hazardous materials contained in each load so that appropriate information is available should an emergency arise
- ◀ Hold PTS (Personnel Track Safety) certification only if there will be a requirement for them to go on or about the operational railway (i.e. Network Rail)
- ◀ Have experience of a similar role
- ◀ Successfully complete Crossrail Tunnel Safety Card (TSC) training
- ◀ Attend local Tunnel Induction training and be trained in the requirements of this Best Practice Guide
- ◀ Be fully briefed and conversant with all relevant local procedures
- ◀ Be trained in the application of this Best Practice Guide. This training will be supported by refresher training and any other briefings as deemed appropriate by local management

The contractor will ensure that there is adequate cover for this post at all times.

The contractor will ensure that there are local instructions in place which cover key issues including:

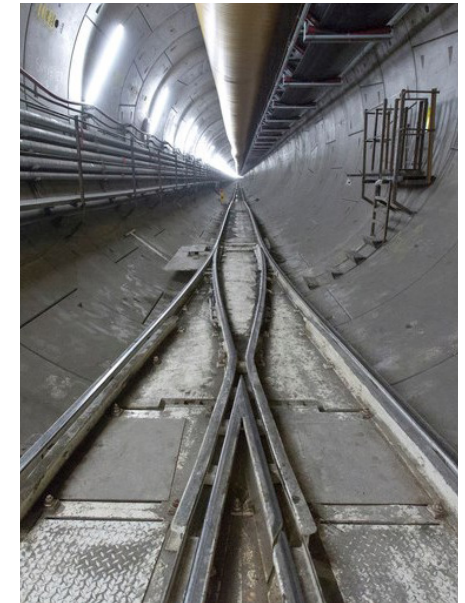
- ◀ Use of the Operations Board
- ◀ What information is recorded
- ◀ How and where information is recorded
- ◀ How train locations are known by the OBC
- ◀ Priority assignment on California crossings

Note: Where there is a permanent single line running arrangement (i.e. only one train on the track at any given time), it will not be necessary to engage an OBC, but ONLY if the contractor has put in place adequate arrangements to protect the train and those working in the tunnel.

Flagman

Where a flagman is engaged (e.g. at a California crossing) they shall:

- ◀ Hold CSCS Certification RED (Experienced Worker)
- ◀ Receive a minimum of 12 hours familiarisation training
- ◀ Have been assessed as competent to carry out all activities associated with the role
- ◀ Successfully complete Crossrail Tunnel Safety Card (TSC) training
- ◀ Attend local Tunnel Induction training
- ◀ Be fully briefed and conversant with all relevant local procedures
- ◀ Be trained in the application of this Best Practice Guide. This training will be supported by refresher training and any other briefings as deemed appropriate by local management



Back-up operator / slinger

The Back-Up Operator shall:

- ◀ Hold CSCS Certification RED (Experienced Worker)
- ◀ Have experience of working within and on a TBM
- ◀ Have receive a minimum of 12 hours familiarisation training
- ◀ Have been assessed as competent to carry out all activities associated with the role
- ◀ Have successfully complete Crossrail Tunnel Safety Card (TSC) training
- ◀ Attend local Tunnel Induction training

- ◀ Be fully briefed and conversant with all relevant local procedures
- ◀ Carry out all duties as defined in local working instructions
- ◀ Operate the Manchester gate as and when required
- ◀ Supervise the ingress / egress of personnel movements into and from the stationary man rider
- ◀ Be trained in the application of this Best Practice Guide. This training will be supported by refresher training and any other briefings as deemed appropriate by local management



Section A3 Pre-use Checks

Locomotives and rolling stock

Locomotives and rolling stock scheduled for use will be inspected by the driver at the start of each day to ensure that it is fit for service and capable of delivering safe operation. This inspection will include a brake functionality test (as required by BS 6164:2011).

The Daily Loco Checklist (DLC) remains on the locomotive; any defects or issues identified by the driver are to be logged at the first available opportunity prior to use.

Unserviceable safety critical equipment must be removed from use as soon as a defect is identified.

The DLC is to be checked daily by the locomotive fitters who will:

- ◀ Review entries
- ◀ Carry out and record any necessary repairs
- ◀ Schedule or carry out routine maintenance as appropriate
- ◀ Report recorded defects to the OBC
- ◀ Complete a record of all work carried out on the locomotive

The driver will test on board communications and confirm both the locomotive and communications are operational with the OBC prior to

receiving instructions at the start of each shift.

Train-borne plant

The following items are to be checked by fitters at predetermined periods:

- ◀ The engine compartment fire suppression system
- ◀ The hydrostatic transmission and retarder
- ◀ Pneumatic wheel brakes

In addition, couplers and chains (for the rolling stock) are to be checked by drivers before each movement.

Should any of the above items be found to be defective during checking, the loco fitter should be consulted and appropriate remedial action taken.

Training and briefing

The following are to be applied:

- ◀ Locomotive drivers must have received familiarisation training on the locomotive they are driving and have been assessed as competent to drive
- ◀ All personnel on site are to be briefed in the communication procedure so that they are aware of actions to take in the event of an emergency

Locomotive driver aids

The following checks are to be carried out by the loco driver at the beginning of each shift:

- ◀ CCTV system is functionally tested and camera lens wiped clean
- ◀ Functional brake test
- ◀ Test that lights are operational and showing correct direction of travel
- ◀ Communication system is functionally tested
- ◀ Locomotive Electronic Control is tested
- ◀ Horns tested

Note: The locomotive should not be used if any of these systems are defective.

Rail Movement Control Centres (RMCCs)

Where RMCCs are in use, the following will apply:

- ◀ Where the RMCC is equipped with CCTV cameras they are to be tested and confirmed to be working correctly by the OBC at the beginning of each shift
- ◀ The communication system in the RMCC is tested and confirmed to be working correctly by the OBC at the beginning of each shift

Communications and signalling equipment

The following will be applied for communications and signalling equipment:

- ◀ The tunnel radio system is to be functionally tested by the OBC at the start of each shift
- ◀ The CCTV system (where installed) is to be functionally tested by the OBC at the start of each shift
- ◀ Signs are to be installed establishing the maximum speed at relevant sections (e.g. California crossings)
- ◀ "Trains have priority" signs are to be installed at all level crossings
- ◀ Cameras are to be installed, tested, certified and working at both ends of all crossings

The following horn blasts are to be used in the tunnels to designate the imminent action of a loco:

3 blasts	Moving outbye
2 blasts	Moving inbye
1 long blast	Stopped

A continuous blast is to be given when the driver identifies personnel ahead in the tunnel who have not acknowledged and moved out of the way of the train.

Section A4

Vehicle Movement Safety

General

- ◀ The OBC will be located within a clearly defined area and will be in overall charge of all train movements between the yard / loco stabling area and TBM
- ◀ The Pit Boss (or designated operative where there is no Pit Boss) will be in charge of all train movements up to the TBM
- ◀ The Back-Up operator will be in control of all train movements within the TBM for segment movements, train unloading movements and personnel movements
- ◀ Where flagmen are used they will direct all trains as required and always under the control of the OBC and yard staff to ensure safety
- ◀ In addition to being appropriately trained and certificated, locomotive drivers will have read the operations manual for the locomotive they are operating, and will have been briefed on this Best Practice Guide
- ◀ Passengers are not permitted in the locomotive cab at any time EXCEPT
 - when the driver is under training and the passenger is the instructor
 - if the passenger is someone authorised to inspect track, signals etc. (but only if there is a seat in the loco cab)
- ◀ Apart from walking along approved safe walking routes, personnel transport into the tunnel will be by man rider only. Travelling on any other part of the train is prohibited
- ◀ Carrying work equipment or materials in the man rider is prohibited EXCEPT for surveying equipment
- ◀ Pedestrians are not allowed into tunnels unless carrying out surveys, track inspections, maintenance etc. In such cases, access is only permitted under the control of the OBC and with an appropriate Permit to Work in place
- ◀ Pedestrians are only permitted to cross the track on marked safe walking routes
- ◀ All tools and materials are to be kept clear of the track at all times UNLESS work is being carried out on the track. All such work will be carried out under (and in accordance with the requirements of) a Permit to Work issued by the OBC
- ◀ The tunnel will be equipped with a communication system allowing radio communication between the loco operator and other tunnel personnel

- ◀ Inbye and outbye trains will signal their intention to move in accordance with local instructions. Appropriate coloured lights at the front and rear of the train will indicate direction of travel
- ◀ Where local noise restrictions exist, alternative arrangements will be put in place for noise restricted times
- ◀ Train movements in working areas of the TBM will be controlled by the local TBM traffic light; the loco driver will comply with the traffic lights which are controlled by the appointed Back-Up Operator
- ◀ Parked trains or trailers will be individually air braked and wheel scotches placed under wheels of uncoupled rolling stock. Scotches may be of wooden or metal construction. Dog chains (or similar) are not permitted
- ◀ Brakes and scotches / rail clamps are to be applied on static uncoupled trailers to prevent them running away
- ◀ The loco driver will be responsible for carrying out checks of the loco to ensure that it is fit for service. Checks are to be carried out in accordance with the mechanical and operational manual checklists provided by the loco manufacturer

- ◀ The loco driver will be responsible for carrying out checks to ensure that there is adequate clearance along the route for the train to travel safely without risk of colliding with obstructions; adherence to gauge limits must be ensured
- ◀ Tampering with couplings is forbidden
- ◀ Prior to inbye movements, both the loco driver and the yardman will check train loads to ensure they are secure
- ◀ Engines should be switched off when not required to reduce unnecessary fuel consumption and emissions



Tunnel movements

The following are to be applied for all tunnel movements:

- ◀ The maximum train speed within the tunnels is to be displayed on signposts at appropriate locations; this speed limit is an absolute and is not to be exceeded at any time
- ◀ The maximum speed for traversing a California crossing will be 5km/h; warning notices are to be placed 60m either side of the crossing instructing loco drivers to slow down
- ◀ Movement direction lamps at the front and rear of the train are to be illuminated at all times to indicate the direction of travel. The lights should show white at the front of the train in the direction of travel and red at the rear when a travel direction is selected

- ◀ When passing personnel in the tunnel the train driver will sound the horn to advise of his approach; the personnel concerned are to wave a hand to acknowledge that they are aware of the approaching train
- ◀ Walking in the tunnels is not encouraged. However it is acknowledged that teams are required to work in the tunnels at certain times. When doing so they will protect their working area with advanced warning lights which may be obtained from the OBC; these warning lights are to be placed 60m either side of the work area. Such works may only be carried out under a controlled Permit to Work (PTW) in accordance with local arrangements

- ◀ PTWs will be held by the OBC who is responsible for briefing all relevant personnel on the content of the PTW including the nature of the work and number of personnel in the work group
- ◀ Loco drivers are to be continuously advised of all PTWs that are introduced / signed off during a shift
- ◀ PTWs are only signed off when the work is complete, the site has been made safe and all members of the working group are accounted for. A PTW may be passed to a subsequent working group, but the names of all outgoing and incoming personnel must be recorded in accordance with the local PTW procedure
- ◀ There will be intermediate stop points (crossings and booster locations) where workers will be able to alight, but always within the confines of the PTW and under the control of the OBC
- ◀ Personnel may only board / disembark from a Manrider in the tunnels when the Manrider is stationary in an appropriately designated area
- ◀ All derailments must be reported for appropriate investigation, identification of trends and implementation of corrective actions. Should a derailment occur, local procedures for re-railing are to be followed

No work is permitted to start in the tunnels until a Permit to Work is in place.

Uncoupling trailers

The following actions are to be taken when uncoupling wagons and trailers:

- ◀ Apply parking brakes and put scotches / chocks in place before uncoupling; no unbraked vehicles should be allowed in the tunnels
- ◀ Install the scotch / chock on the downhill side of the trailer; if 'downhill' is not clear (or if the vehicle is on level ground), clamps should be applied at both back and front
- ◀ Verify that brakes are still on
- ◀ Disconnect lighting, CCTV and telephone cables
- ◀ Disconnect hydraulic brake lines ensuring that all supplies are isolated as per the operational instructions for the vehicle
- ◀ Check again that the brake is applied and that scotches / chocks are firmly in place
- ◀ Disconnect the safety chain and then uncouple the vehicle
- ◀ The vehicle may now be left



Coupling trailers

The following actions are to be taken when coupling / uncoupling wagons and trailers:

- ◀ Where Manchester gates have been installed, they must be kept closed until the fully coupled train is ready to move into the tunnel
- ◀ Ensure scotches / chocks are in place before commencing coupling
- ◀ Connect vehicles using couplers and secure the safety chain. Safety chains must be loose enough to allow the trailers to travel round bends in the tunnel but not so long that they are able to touch the track
- ◀ Connect the hydraulic brake lines. Care must be taken to ensure that connections are clean and seated properly with no leaks. Visual / audible checks are to be carried out. Hydraulic pipes must not touch the track
- ◀ Connect lighting, CCTV and telephone cables
- ◀ Once all the above connections have been completed the scotches / chocks may be removed and the vehicle can then be moved

NOTE: Vehicles should not be moved until the driver has confirmed that the train is fully functional.

Trains entering the TBM backup

The following rules are to be applied for all trains entering the TBM backup:

- ◀ The train must signal its arrival by sounding the horn in accordance with local procedures and stop in front of the Manchester gate
- ◀ No train movements are to take place at the rear of the TBM until the Back-Up operator on the TBM has confirmed to the loco driver that:
 - All personnel are clear of the track
 - No personnel are attempting to board or disembark from the man rider
- ◀ The appointed Back-Up Operator will co-ordinate with the Pit Boss via two-way radio to sequence the unloading of the train at the various gantries where the traffic light controls are placed
- ◀ When the Manchester gate is open the free access will be indicated with a green light indicating permission to move inbye. The Manchester gate opens only through hand operation controlled by the appointed Back-Up Operator

- ◀ The locations for stopping the train will be marked on the gantries and indicated by a switch of the traffic light to red. Entry to the rear of the TBM must be at creeping speed
- ◀ One long blast on the loco horn will be used to indicate that the loco has stopped moving and brakes have been applied. Personnel entering or leaving the man rider will only do so when given the all clear by the appointed Back-Up Operator
- ◀ Once the train is unloaded it will leave outbye the TBM backup at creeping speed once a blue light is displayed
- ◀ The Appointed Back-Up Operator will check before permitting movement of the man rider that no personnel are attempting to board the train before it departs
- ◀ Once the operation is complete, the loco will not be permitted to move off until the appointed Back-Up Operator has indicated to the loco driver that no personnel are attempting to board or disembark from the man rider
- ◀ Immediately prior to moving off the loco driver will sound three blasts of the loco horn to indicate that the loco is moving outbye



Track inspections and maintenance

Track inspection and maintenance activities will be completed by a dedicated track maintenance team on a scheduled basis (additional works will be carried out as necessary). This work will be compliant with the following:

- ◀ Local processes will be in place to detail routine maintenance, planned preventive maintenance, breakdown repair protocols and re-railing procedures
- ◀ Local processes should include information on when train movements are to be stopped for emergency maintenance (e.g. submerged track, build up of grease in points etc.)
- ◀ The Designated Person / Persons undertaking track maintenance must be known / communicated to drivers and other tunnel personnel
- ◀ All track maintenance and inspection activities must be carried out under a Permit to Work issued by the OBC
- ◀ Any track defects are to be reported to the OBC as soon as they are identified, by whoever identifies them
- ◀ In order to avoid derailments, the track will be inspected visually during the routine maintenance shift. Bolts will be retightened as necessary
- ◀ Visual inspections are carried out following any change to the track; fishplate bolts as well as any other clips and fixings are to be physically checked
- ◀ In the event of a derailment, any affected track must be fully inspected and appropriate remedial action taken where necessary
- ◀ Spillage of materials that may affect safe train operation will be reported to the OBC who will make arrangements with the Pit Boss / Tunnel Superintendents for the spillage to be cleared as soon as practical
- ◀ Track geometry will be checked (gauge and rail inclination). Special attention is to be paid to track at the portals and sections with very small radius (<40-50m) in order to avoid derailments
- ◀ Checks are to be carried out on the different geometrical parameters of the California crossings in order to avoid derailments
- ◀ Following any change to the track, gauge is to be checked and movements only permitted when confirmation is given that gauge is correct
- ◀ Personnel working on the railway will wear the appropriate PPE and will operate under a Permit to Work in accordance with the local procedure
- ◀ The invert is to be kept clear of hazards as far as reasonably practicable; the underside of the rails must be visible above any muck in the invert

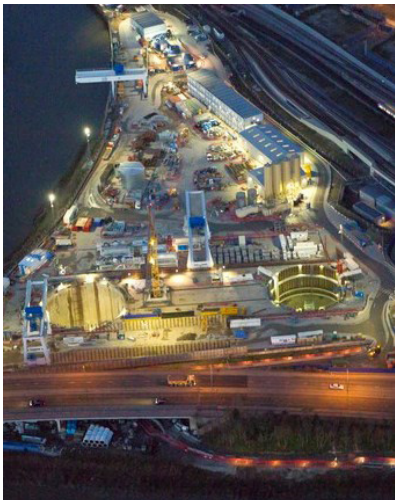
Loading and unloading (yard)

The following are to be applied for loading and unloading activities:

- ◀ The yardman is responsible for supervising the loading/unloading of all plant, equipment and materials onto / off of trains
- ◀ On each trip to and from the yard and TBM a record is to be maintained of what has been loaded / unloaded onto each loco; the departure time is also to be recorded

When loading / unloading in the yard the yardman and the loco driver must make sure materials are:

- ◀ Correctly loaded
- ◀ Secured to prevent them from moving
- ◀ Not in excess of the maximum load for the loco



Loading and unloading (TBM)

The Pit Boss (or in his absence the lead miner) and the loco driver must make sure that a competent person supervises the loading/unloading of the loco. This includes ensuring that the load is:

- ◀ Correctly loaded
- ◀ Secured to prevent movement
- ◀ Within the maximum load limit for the vehicle
- ◀ Within the maximum gauge limit for the track

The Pit Boss (or in his absence the lead miner) and the loco driver must sign the loading note and train log book to certify the load as being correct and safe to travel.

Loco and train maintenance

- ◀ The locomotives and trailers are to be checked and maintained according to the manufacturer's operation manual
- ◀ Maintenance is only to be carried out by competent personnel appointed in accordance with the requirements of BS 6164 : 2011
- ◀ A record is to be maintained of all maintenance and repairs carried out on the loco and trailers
- ◀ Where a defect has been identified that makes the loco / train unfit for safe use, it is not to be used until appropriate remedial action has been taken
- ◀ Maintenance and repairs are only to be carried out in designated areas. It is forbidden to carry out any maintenance / repair activities outside the designated areas EXCEPT when the train has failed in the tunnel and must be repaired before it can be moved

Use of new plant

- ◀ The Tunnel Manager must approve any new plant that is to be used in the tunnel
- ◀ All plant must be recorded on the asset register and regularly checked and maintained in accordance with manufacturers recommendations
- ◀ Maintenance records are to be kept for the new piece of plant, along with records for all other plant currently in use

Refuelling

- ◀ Refuelling will be at a dedicated and segregated area as far from the works area as practicable
- ◀ The refuelling point will be in open air; fuel will be obtained using a hose and trigger nozzle from a tank located on the surface
- ◀ The trigger is to be locked off when not in use
- ◀ Bulk spill containment, fire extinguisher and oil binder will be in place as close to the fuelling point as practicable
- ◀ Leaving the nozzle unattended while refuelling is underway is prohibited in all circumstances; if it is necessary to leave the refuelling point the nozzle must be removed and replaced in its' retainer on the pump

Communications protocols

OBCs are to have overall responsibility for management of communications. In all cases:

- ◀ Instructions issued by the OBC are to be followed UNLESS it is believed that the instruction may present a risk



- ◀ Instructions issued by the OBC take precedence over all other instructions relating to the railway UNLESS it is believed that the instruction may present a risk
- ◀ All communications relating to incidents (including near misses) are to be recorded by the OBC
- ◀ When communicating alphanumerics, the phonetic alphabet is to be used at all times (see Section D)

Emergencies

Local emergency response procedures are to be followed.



Part B – Tunnel Vehicle Maintenance

Section B1

General

All rail vehicles are required to be maintained in accordance with a maintenance plan.

The organisation responsible for management of the construction railway must obtain the maintenance documentation which details vehicle maintenance activities from the vehicle manufacturer. Maintenance activities include all activities necessary such as inspections, monitoring, tests, measurements, repairs, replacements and adjustments.

Maintenance activities are split into:

- ◀ Preventive maintenance; scheduled and controlled
- ◀ Corrective maintenance (repair)

Maintenance documentation should include the following:

- ◀ Component hierarchy and functional description. The hierarchy should list all the items belonging to the vehicle and use an appropriate number of discrete levels; the lowest level shall be a replaceable unit
- ◀ Schematic circuit diagrams, connection diagrams, wiring diagrams, pneumatic schematics and lubrication diagrams

- ◀ The limit values for components which must not be exceeded in service shall be stated. The possibility to specify running restrictions in degraded mode (limit value reached) can be considered
- ◀ Records of maintenance work carried out



The maintenance plan.

- ◀ This is the structured set of tasks that include the activities, procedures, means and the working time required to carry out the maintenance task
- ◀ It contains a description of the maintenance activities which include the following:
 - Disassembly / assembly drawings & instructions necessary for correct assembly / disassembly of replaceable parts
 - Maintenance criteria
 - Checks and tests
 - Tools and materials required to undertake the task
 - Consumables required to undertake the task
 - Personal protective safety provision and equipment
 - Necessary tests and procedures to be undertaken after each maintenance operation before re-entry in to service of rolling stock
 - Checks on lifting / jacking point
- ◀ Troubleshooting (fault diagnosis) manuals or facilities for all reasonably foreseeable situations. This includes functional and schematic diagrams of the systems or IT-based fault finding systems



Section B2

Maintenance plans - General

Relevant to all vehicles

Vehicle maintenance activities are only to be carried out by appropriately qualified personnel.

- ◀ The maintenance plan shall detail all maintenance activities to be undertaken on the applicable type of rail vehicle
- ◀ The maintenance plan should include all maintenance activities that must be carried out to ensure that the rail vehicle(s) continue to conform to the safe limits defined by the vehicle manufacturer

- ◀ The maintenance plan shall, as a minimum, include the following:

- Maintenance requirements including the safety conditions to ensure the rail vehicle can be safely worked on for each task
- A maintenance schedule which defines the periodicity at which each item shall be actioned
- An inspection programme for regular inspection of the vehicle to confirm that it is safe to continue in service
- Definitions of the appropriate actions to be taken to ensure that all systems and equipment continue to operate safely over the full range of environmental conditions, particularly in snow, flood, freezing or abnormal heat

- Technical instructions that define actions required to ensure that a vehicle can be hauled safely when inoperative (e.g. the adjustment, isolation, removal or addition of some components or the imposition of a restrictive maximum speed to travel)
- The minimum engineering maintenance facilities that are necessary for the maintenance to be carried out (e.g. pits, major equipment, covered work areas)
- The minimum level of competencies required for the staff carrying out the specified maintenance tasks

- ◀ Each rail vehicle shall be maintained so that the prescribed tolerances for all components and assemblies are not exceeded throughout the life of the vehicle



Section B3

Maintenance Plans - Specific

Relevant to all vehicles

Wheelsets

The maintenance plan shall, as a minimum, set out the requirements for the following items of the wheelset and constituent parts:

- ◀ Relative movement of wheels, axles, tyres and axle mounted equipment
- ◀ Cracks and fractures
- ◀ Dimensions affecting running safety:
 - Minimum wheel diameter
 - Tolerance between diameters of wheels on the same axle
 - Tolerance between diameters of wheels on the same bogie or rail vehicle
 - Back to back dimensions
 - Flange and tread profile
 - Wheel tread surface damage
 - Wheel flat limits

Brakes

- ◀ The maintenance plan should detail that the components of rail vehicle brake systems are maintained at appropriate periods
- ◀ Maintenance activities and periods must be designed to ensure that the brake systems function correctly and safely between maintenance activities

- ◀ Functional tests of the brake systems should be carried out to ensure that they are operating correctly. This should take into account the environment in which the vehicle is being used
- ◀ The functional brake tests should show that the systems respond to graduated brake application demands, up to and including an emergency stop
- ◀ Brake cylinder pressures should be checked to confirm that pressure increases in proportion to the controller movement
- ◀ Appropriate functional brake tests should be undertaken whenever components of the brake system are replaced and reconnected or following component repair, renewal or disconnection
- ◀ If a fault in a brake system or component is revealed by either the maintenance or functional brake tests, details of appropriate remedial action should be available in the maintenance plan

◀ The maintenance plan shall, as a minimum, set out the requirements for (where fitted):

- Brake disc integrity, condition and dimensions
- Brake pad and brake block integrity and dimensions
- Brake rigging (pins, bushes and associated equipment)
- Integrity of operating devices, reservoirs, hoses, cocks, pipework, safety loops and associated equipment

Rail vehicle structure

- ◀ Vehicles shall be maintained so that the body and running gear remain structurally sound and safe
- ◀ Vehicles shall be maintained so that the connections between the body and running gear remain structurally sound and safe
- ◀ Prescribed tolerances must be checked and maintained – this includes all components, assemblies and systems

Speed indicating equipment

- ◀ The maintenance plan must include a method for testing speed indicating equipment – this must include acceptable tolerances. If readings are outside this tolerance, the speed indicating equipment must be corrected before the vehicle re-enters service

◀ The speedometer test shall cover the whole range of the speed indicating equipment. The test, shall cover:

- The accuracy of readings
- Intermittent or jerky operations
- Clarity and cleanliness of indicators and correct operation of associated lighting
- The integrity of connections and components that cannot be included in the equipment test

◀ As a minimum, speedometer and speed control system testing shall be undertaken in the following circumstances:

- When a wheelset has been replaced
- When a wheelset has been re-profiled
- When the speed indicating equipment, speed control system or their components have been disturbed, adjusted, repaired or replaced
- When there has been a report of a malfunction of the speed indicating equipment or speed control system
- When there has been a report questioning the accuracy of the speed indicating equipment or speed control system
- Following an allegation of exceeding the speed limit

Trainborne signalling and communications equipment

- ◀ All signalling and communications equipment shall be managed to ensure that its integrity and performance remains compliant with its specification
- ◀ The maintenance requirements for each item of trainborne signalling and communication equipment shall be developed to control the risks which would arise from failure of any part the system
- ◀ The maintenance requirements for trainborne signalling and communication equipment shall be documented
- ◀ Maintenance requirements shall form part of the rail vehicle maintenance plan for the vehicle
- ◀ The procedures to ensure configuration control of any software and hardware shall also be documented in the maintenance plan

Headlights

- ◀ The maintenance plan shall set out a method for testing the functionality and alignment of the headlights
- ◀ Testing of the headlights shall be carried out at a periodicity to reflect the use and working environment of the vehicle



Other equipment

Consideration shall be given to the following during the production of the maintenance plan. The list is not exhaustive or necessarily representative of all types of vehicles used on construction railways.

◀ Buffers:

- Heights
- Integrity and condition
- Greasing

◀ Drawgear:

- Dimensions
- Rubber condition
- Integrity and condition
- Operation

◀ Primary and secondary suspension:

- Spring integrity, rules for changing
- Linkage wear, dimensional limits
- Suspension settlement
- Damper integrity

◀ Suspension tube bearings:

- Condition, integrity and security of components and installation
- Bearing float

◀ Traction and auxiliary generators, alternators, other electrical machines and electrical equipment cases:

- Integrity and security
- Earthing condition and integrity
- Presence, condition and cleaning of all safety labelling

◀ Cleaning:

- Ventilation ducts
- Bogies and underframe equipment
- Front end and windscreens

◀ Final drives / transmissions:

- Security to body or bogie frame
- Condition checks of safety critical items
- Lubrication
- Safety loops
- Presence and security of balance weights, where fitted

◀ Internal combustion engines:

- Security and condition of mountings
- Checks for leakage of fluids
- Integrity of shaft couplings
- Engine safety systems (for example, overspeed, crankcase explosion)
- Emissions (compliant with specification)

◀ Power systems (including associated protection systems):

- Integrity and security
- Earthing condition and integrity
- Presence, condition and cleaning of all safety labelling

◀ Hydraulic and pneumatic systems:

- Condition and integrity of hoses, pipework, valves, etc

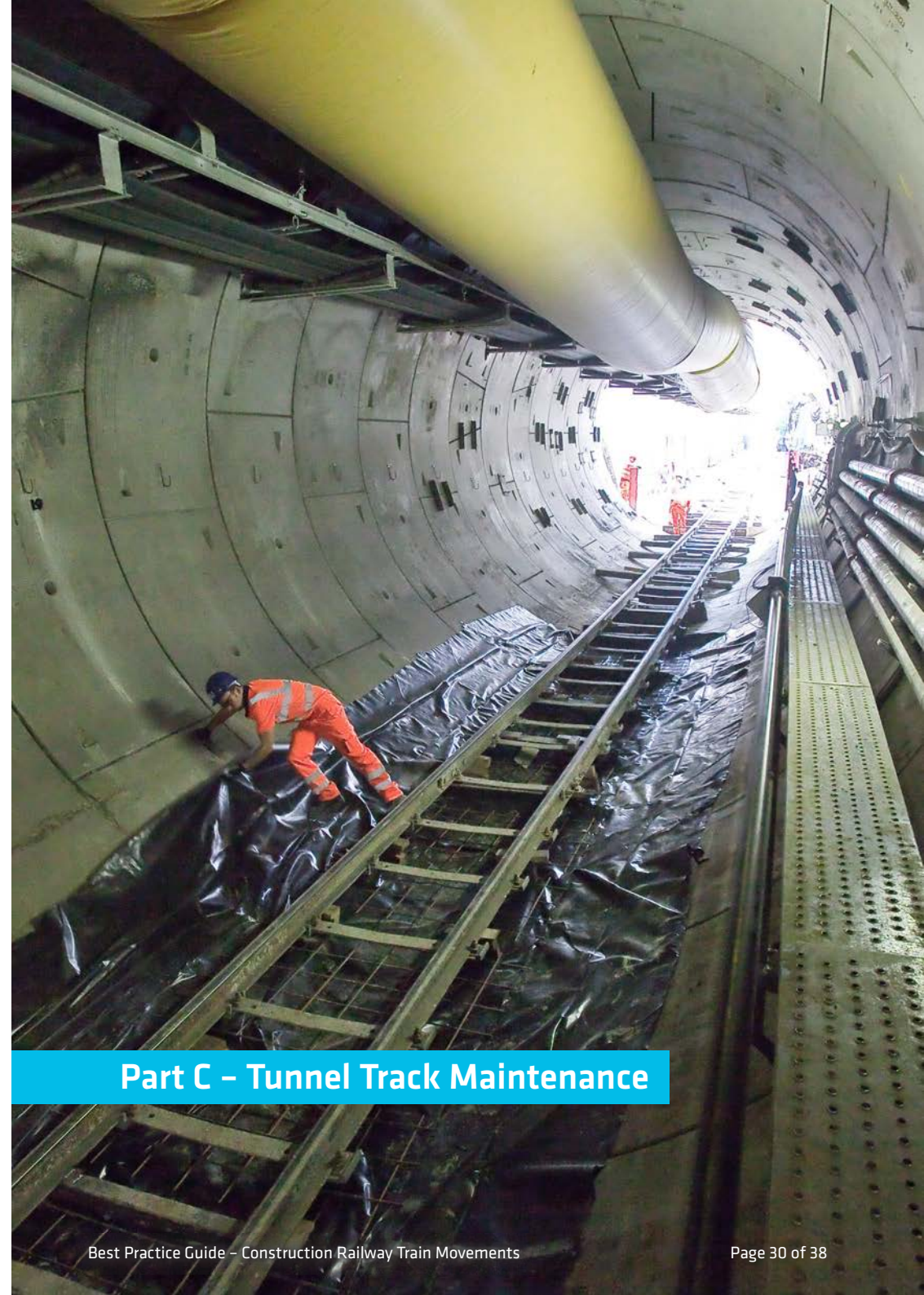
◀ Fire protection systems:

- Integrity and condition
- Currency of certification

◀ Lighting Systems

◀ Emergency Facilities:

- Emergency lighting capacity
- Other emergency and safety equipment provided



Part C – Tunnel Track Maintenance

Section C1

Roles and Competencies

General

This Section defines the general duties and competence requirements of personnel with a role in maintaining track, crossovers and associated equipment on the construction railway. It should be referred to when clarification is required on specific responsibilities.

The role titles used below may not necessarily correspond with job titles in the Contractors' organisation, however the Contractor will be expected to demonstrate that the responsibilities listed below have been discharged by a competent person with sufficient knowledge and experience.



Mechanical Superintendent

The Mechanical Superintendent (or equivalent) shall:

- ◀ Be responsible for ensuring that a track maintenance programme is in place covering all tunnel railways track, California crossings, sleepers, fishplates and associated components
- ◀ Ensure that all track and associated equipment is inspected on a regular basis and to a pre-determined frequency (see section C3 of this Best Practice Guide)
- ◀ Ensure that a forward-looking programme is in place covering the inspection and maintenance of track and associated components
- ◀ Hold CPCS Certification
- ◀ Successfully complete Crossrail Tunnel Safety Card (TSC) training
- ◀ Attend local Tunnel Induction training and be trained in the requirements of this Best Practice Guide and the Contractor's Track Maintenance Procedures

Track Inspector

The Track Inspector shall:

- ◀ Be responsible for carrying out inspection and maintenance of track, California crossings, sleepers, fishplates and associated components to the standards prescribed in the contractors' track maintenance procedures
- ◀ Have received training and hold the necessary competence in the inspection and maintenance of track
- ◀ Report any track defects to the Operations Board Controller (OBC) and Mechanical Superintendent
- ◀ Be responsible for maintaining a record of all track inspections
- ◀ Hold CPCS Certification
- ◀ Successfully complete Crossrail Tunnel Safety Card (TSC) training
- ◀ Attend local Tunnel Induction training and be trained in the requirements of this Best Practice Guide and the Contractor's Track Maintenance Procedures

Note: Tracks laid in the TBM are to be inspected immediately after installation. This can be carried out by an inspector or by any suitably qualified member of the track gang.

Operations Board Controller (OBC)

The Operations Board Controller (OBC) shall:

- ◀ Provide protection for track inspectors whilst undertaking track maintenance and inspection activities
- ◀ Communicate with all locomotive drivers when track inspectors are working in the tunnel
- ◀ Arrange the safe system of work so the location of track inspectors working in the tunnel is known

Note: The Contractor shall ensure that there is continuous cover for this post at all times.

Where there is a permanent single line running arrangement (i.e. only one train on the track at a given time), it will not be necessary to engage an OBC, but only if the contractor has put in place adequate arrangements to protect the train and those working in the tunnel through a permit to work system.

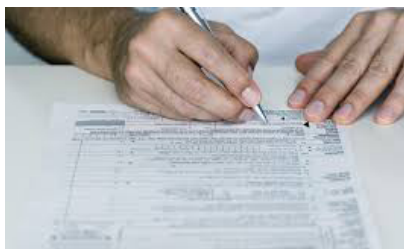
Section C2

Tunnel Tracks Work Permit

Arranging the Track Works Permit

Before any track inspection or maintenance work is carried out, the Track Inspector (or other person undertaking work on or about the track) shall report to the OBC to arrange for a Permit to Work – the Tunnel Track Works Permit - to be issued. The OBC will raise the Tunnel Track Works Permit which will specify, as a minimum:

- ◀ The location of the works to be carried out
- ◀ The names and details of persons undertaking the track inspection and maintenance works
- ◀ The means of communication between the Track Inspector and the OBC during the works
- ◀ The duration of the work to be carried out
- ◀ The nature of the work and any requirements for train movements to be suspended or restricted (for example a temporary speed restriction during or after the works)
- ◀ The time at which the permit will be closed



Issuing the Tunnel Track Works Permit

The OBC will sign the Tunnel Track Works Permit and the permit will then be approved by the Mechanical Superintendent, Tunnel Superintendent, Pit Boss or other nominated person named in the contractor's local procedure.



A permit to work must be issued when entry to the tunnel is required to carry out track inspection or maintenance duties, irrespective of whether train movements are taking place or not.

Cancelling the Tunnel Track Works Permit

Upon completion of the works, the Track Inspector will notify the OBC that:

- ◀ All personnel are clear of the track and are in a position of safety
- ◀ All tools and equipment have been removed from the track
- ◀ The track is safe for normal operations to be resumed, unless operating restrictions (for example a speed limit) need to remain in place

Section C3

Tunnel Track Maintenance Works

Track Inspection Programme

- ◀ The Mechanical Superintendent will develop a forward-looking programme of track inspections covering a 12 month period
- ◀ The Tunnel Track Inspection Programme will detail the sections of track to be inspected on a particular track patrol, identified by segment ring number
- ◀ The Tunnel Track Inspection Programme will also define any components, for example California Crossings, which require specialised inspections other than a normal visual check
- ◀ Additional visual track inspections shall be undertaken following any reported rough ride, derailment or track defect observed by the loco drivers



Track Inspections

- ◀ The Track Inspection Programme shall ensure that every section of track is inspected at least once every 2 weeks
- ◀ The track inspection will be undertaken on foot under adequate lighting conditions. Where 2 or more lines exist on a stretch of track, each line shall be walked separately
- ◀ The track inspection will include a visual examination of the condition of the track and identification of any rail defects, pitting, track spread or rail buckles
- ◀ At regular intervals defined in the contractor's track maintenance procedure, the track gauge will be measured and recorded using a calibrated track gauge. Where the gauge is outside the prescribed tolerance of 900mm +/- 25mm, the OBC shall be notified immediately
- ◀ Any significant defects in the track, for example broken rail, track spread, buckled rail shall be reported to the OBC and train movements suspended until repairs have taken place or the Mechanical Superintendent has confirmed that it is safe for passage of trains
- ◀ Track inspections shall be recorded on a proforma defined in the contractor's track maintenance procedure

Track Bed

The track inspection shall include a visual examination of the sleepers & track bed, which will take place as part of the track inspection, including:

- ◀ Loose or missing Pandrol clips, or other rail to sleeper fixture
- ◀ Broken or damaged sleepers
- ◀ Loose or damaged “anchors” which connect the sleepers to the concrete segments
- ◀ Build up of oil, waste material, or excessive water on or around the track bed

Fishplates and bolts

The track inspection shall include a visual examination of the fishplates and fishplate bolts, which will take place as part of the track inspection, for:

- ◀ Loose or missing fishplate bolts
- ◀ Broken or cracked fishplates
- ◀ Condition of the grease between the fishplate, the fishplate bolts and rails

Where “dry joints” are detected, the fishplate bolts will be loosened, grease will be applied to the rail edges of the fishplate and bolts, then the bolts shall be re-tightened using a torque spanner to the setting prescribed in the contractor’s track maintenance procedure.



California Crossings

California Crossings represent a higher risk of derailment than plain line track and therefore an enhanced inspection regime shall be adopted.

The frequency of inspections of California Crossings and associated switches shall be at least twice weekly. Inspections shall be undertaken by the Track Inspector and recorded on the contractor’s record of track inspection.

Inspections of California Crossings shall additionally be undertaken following any report of rough ride, derailment or other malfunction reported to the OBC.

Inspections of the California Crossing shall include:

- ◀ A visual check of the crossing, including the switch blades, for signs of damage, corrosion, wear and obstructions in the switch blades
- ◀ A check of the movement of the switch blades from normal to reverse positions and back
- ◀ Application of mineral or bearing grease to the moving parts of the switch blades
- ◀ A visual check of the mechanical parts of the California Crossing, to include the tie rods, stabilisers, section connections, point levers and spring mechanisms
- ◀ In the case of a post-derailment inspection, the Track Inspector shall observe train movements in both directions over the crossing to check the operation

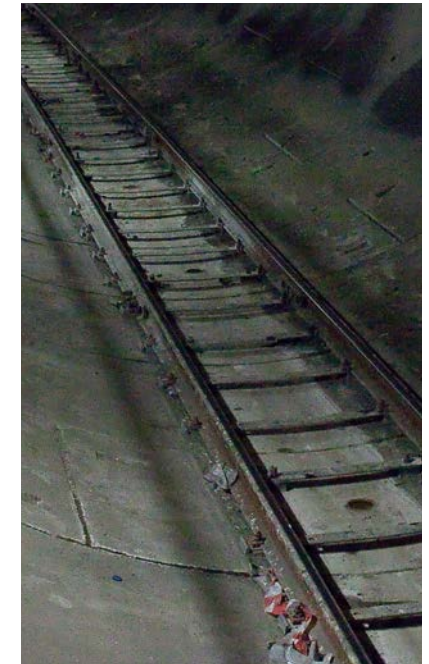
Records of Track Inspections

A bespoke record of track inspections and maintenance shall be kept for every track inspection. The completion of the record of track inspection shall be defined in the contractor’s track inspection procedures.

The record of track inspection shall include the following information, as a minimum:

- ◀ The date and time of the track inspection
- ◀ The name and signature of the Track Inspector

- ◀ The section of track patrolled – identified by segment ring numbers
- ◀ The line patrolled, where more than one exists
- ◀ Nature of any defects identified
- ◀ Any work that was identified from the inspection that could not be completed at the time
- ◀ Overall remarks on the condition of the track and any potential defects which could arise before the next scheduled inspection





Part D – Additional Information

Section D1

Additional Information

Glossary of terms used in this Guide

CCTV	Closed Circuit Television
DLC	Daily Loco Checklist
MC	Movement Controller
OBC	Operations Board Controller (Note – on sites where there is no OBC, a designated Authorised Person may be installed)
PTW	Permit to Work
RMCC	Rail Movement Control Centre
TSC	Tunnel Safety Card

External standards that support the use of this Guide

BS 6164:2011

Code of practice for health and safety in tunnelling in the construction industry

BS EN 1889-2:2003

Machines for underground mines – Mobile Machines working underground – Safety

Phonetic alphabet

A	Alpha	J	Juliet	S	Sierra
B	Bravo	K	Kilo	T	Tango
C	Charlie	L	Lima	U	Uniform
D	Delta	M	Mike	V	Victor
E	Echo	N	November	W	Whisky
F	Foxtrot	O	Oscar	X	X-ray
G	Golf	P	Papa	Y	Yankee
H	Hotel	Q	Quebec	Z	Zulu
I	India	R	Romeo		

Numerals should be spelled out, not given as whole numbers:

121 is 'one-two-one', NOT 'one hundred and twenty one'



MOVING LONDON FORWARD

