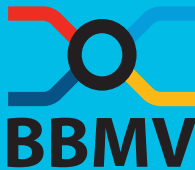


# ◀ **BEST PRACTICE GUIDE** **SCL EXCLUSION ZONE** **MANAGEMENT**



# A best practice guide produced in collaboration between



**SKANSKA**



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**Part A – General**

## Section A

# General

### Purpose

Falling ground or immature (green) concrete within sprayed concrete lined tunnels is a major risk to personnel working in a tunnel, and the main mitigation measure to prevent injury is the use of exclusion zones for high risk areas.

The purpose of this document is to provide guidance on the consistent application of control measures to be used on Crossrail sites in the management of exclusion and restriction zones around active working areas in tunnels employing the Sprayed Concrete Lining (SCL) methodology. This guidance document has been prepared following discussions within CRL, with the SCL contractors and with the designers working on the project.

The guidance provided within this document should not be transferred to other projects without full consideration of the specific risks associated with the ground, methods of working, plant, materials used and the competence and experience of personnel being taken into consideration.

All tunnel working activities shall be carried out in accordance with BS 6164: 2011 'Code of Practice for Health and Safety in Tunnelling in the Construction Industry', and this document discusses supplementary guidance information which should be followed to assist in complying with the requirement to restrict access for personnel (BS 6164 Table 1) in zones subject to SCL falls.

### Scope

The information provided in this document is applicable to all SCL works on the Crossrail project and has been prepared to establish principles in relation to protecting personnel from falling ground or immature concrete close to the working face. This document relates to all areas of a tunnel where initial and primary linings are being sprayed, including the breakout for junctions and construction of connecting tunnels. The principles listed within this guidance document concerning exclusion zones also apply to the construction of sprayed concrete secondary linings and may be followed with suitable adjustments to consider the larger areas impacted and access routes available.

The information provided here relates only to the management of, and testing for safety related to potential falls close to working areas. Other testing requirements for control of the quality of the works are described within the Works Information and must continue to be undertaken at the frequencies defined.



## Definitions

For the purposes of this document the following definitions shall apply and should be used across the project in all documentation relating to this subject:

Exclusion Zone – an area defined on site where no personnel will be allowed to enter under any circumstances.

Restricted Area – an area defined on site where there is authorised access for defined personnel only, including supervision and engineering teams. Restricted areas may be split into separate areas with the higher number (e.g. Restricted Area 2) being closest to the Exclusion Zone or working face.

Normal access zone – an area defined on site where authorised access through normal tunnel entry procedures is allowed.

## Roles and Responsibilities

The following defined roles should be identified and confirmed at each shift briefing. The decision on who is best placed to take on these roles shall reside with the Principal Contractor responsible for the safety of personnel within the particular work area.

At no time should a person undertaking a task that could distract them from the role in question be in a position named below.

The use of competent deputies and delegation of authority should be established to cover times when the main named responsible person is away from the work area, or will be distracted by undertaking his own defined tasks to complete the works.



## Exclusion Zone Supervisor

Responsibilities include:

- Monitoring and maintenance of the systems in the work place required to define and communicate the limits of the exclusion zone
- Agreeing with the Exclusion Zone Engineer (see below) that an Exclusion Zone can be temporarily or permanently released to a Restricted Area

## Exclusion Zone Supervisor (deputy)

Responsible for undertaking the Exclusion Zone Supervisor's role when nominated by that person, with suitable people identified at the briefing at the start of each shift.

## Exclusion Zone Engineer

In most circumstances this will be the Shift Engineer or his identified deputy for this role, but can be anyone competent at carrying out the appropriate testing. Responsibilities include:

- Performing any specified tests related to the release of an Exclusion Zone
- Monitoring any defined time periods related to the first testing for the release of an Exclusion Zone
- Agreeing with the Exclusion Zone Supervisor (or nominated deputy when acting as the Supervisor) that an Exclusion zone can be temporarily or permanently released to a Restricted Area





## Section B – Exclusion Zones and Restricted Access



## Section B

# Exclusion Zones and Restricted Areas

### Requirements for a defined Exclusion Zone

The following are the minimum requirements that should be in place for an Exclusion Zone and should be communicated to all personnel entering the tunnel and considered on a risk based approach taking due cognisance of the prevailing conditions and methods:

- Defined minimum strength of the last concrete sprayed before an Exclusion Zone may be changed to a Restricted Area. This should be demonstrated by calculation by the contractor's designer, accepted by the Crossrail Project Manager, and shall not be less than 0.25MPa
- Defined time before the strength testing is first carried out by an approved method
- Defined minimum distance from the working face or a defined position at the face. For the Crossrail project this shall not be less than 2m
- A physical barrier defining the boundary between the Exclusion Zone and the Restricted Area at all times except during excavation

### Requirements for a defined Restricted Area

The following are the minimum requirements for a Restricted Area and shall be considered on a risk based approach taking due cognisance of the prevailing conditions and methods. This area should always be as safe as reasonably practical with safe systems of work established for all activities undertaken in this area.

- A visible barrier defining the boundary between the Restricted Area and the Normal access zone
- A minimum length of the total Restricted Area
- A list of personnel entitled to be within each Restricted Area
- A maximum number of personnel normally expected to be within each restricted area during spraying operations
- A maximum number of personnel normally expected to be within each restricted area during excavation operations
- Arrangements to be put in place to allow other personnel to enter a restricted area for a special reason. In some cases this will involve stopping work or restricting plant movement

## Control of Exclusion Zones

The Exclusion Zone will be under the control of the named Exclusion Control Supervisor or his nominated deputy, and under no circumstances should this person be in a position where they could be distracted from this function. At all times the following must be in place when an Exclusion Zone is in operation:

- A physical barrier between the Exclusion Zone and the Restricted Area at all times except during tunnel excavation
- A clear board or sign explaining the Exclusion Zone limits under particular work activities (see example in Appendix)

## Release of Exclusion and Restricted Zones

The following process should be followed during working activities before an Exclusion Zone can be released to a Restricted Area:

- At the end of spraying activities for the particular advance, spray test panels for strength control testing using percentage dosage of accelerator used in the advance

- After a defined time for the first test, monitor the strength development of the test panel using a properly calibrated penetrometer following the manufacturer's and relevant BS guidelines with a sufficient number of tests to remove variability concerns in the results
- When the panel test results have achieved the specified minimum strength level, confirm agreement between the Exclusion Zone Supervisor and Exclusion Zone Engineer that these requirements have been met and it is acceptable to undertake penetrometer tests on the profile of the last sprayed concrete
- Undertake strength development test, using a penetrometer, of the last sprayed profile to confirm that this has achieved the minimum strength specified. This test should be undertaken by standing as close to the side wall as possible. The central area of the tunnel should remain an Exclusion Zone where geometry (size) permits. Use of specially formed protective canopies should be employed where deemed necessary to ensure the safety of personnel working in this area



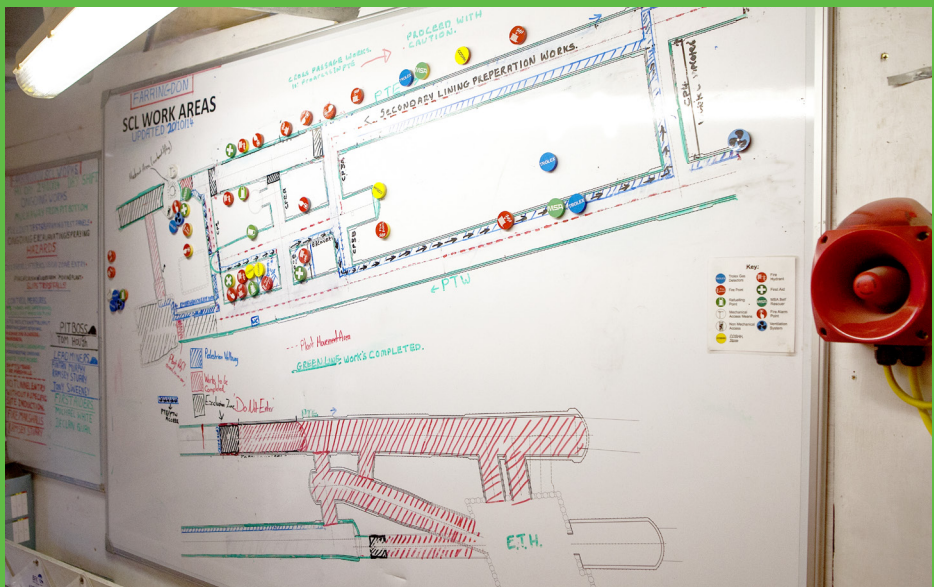
- When the Exclusion zone Supervisor and Exclusion Zone Engineer agree that all minimum requirements have been met, the Exclusion Zone Supervisor may release the zone to a Restricted Area for defined operations within this area. All works within this area should be undertaken within 2m of the side wall with the central section of the tunnel (ie under the crown between approximately 10 o'clock and 2 o'clock) should remain an Exclusion Zone where tunnel geometry allows. Use of specially formed protective canopies should be employed where deemed necessary to ensure the safety of personnel working in this area

Where tunnel geometry has allowed a central area Exclusion Zone under the crown to remain, release of the full face area shall only be permitted when:

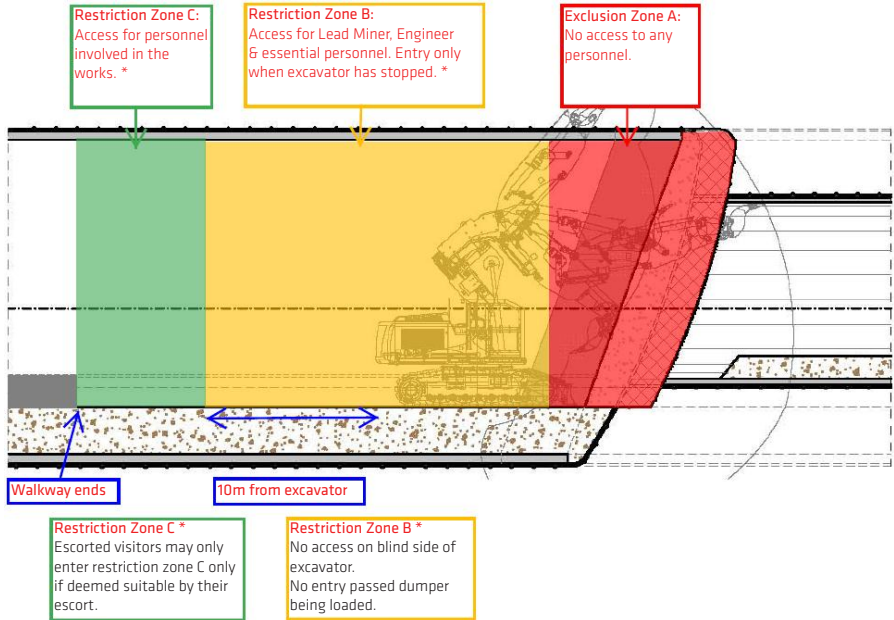
- All the above criteria for the release of an Exclusion Zone have been met
- Additional criteria set by the contractor and accepted by the CRL PM for strength gain or time delay have been met

A Restricted Area may be released to a Normal Access Zone when:

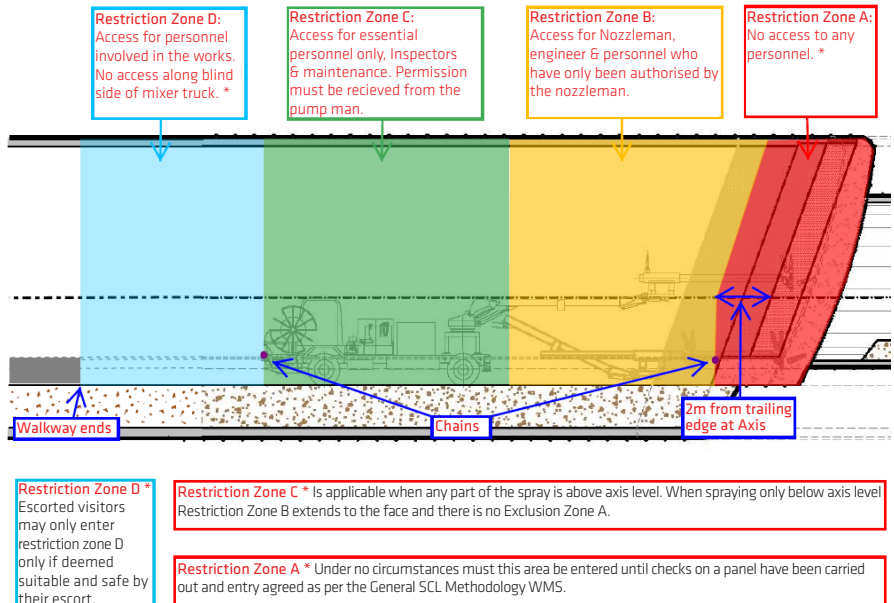
- The exclusion zone has advanced or been removed so that the minimum length of the Restricted Area(s) is not breached
- The Exclusion Zone Supervisor or his deputy has agreed that a change in status is acceptable

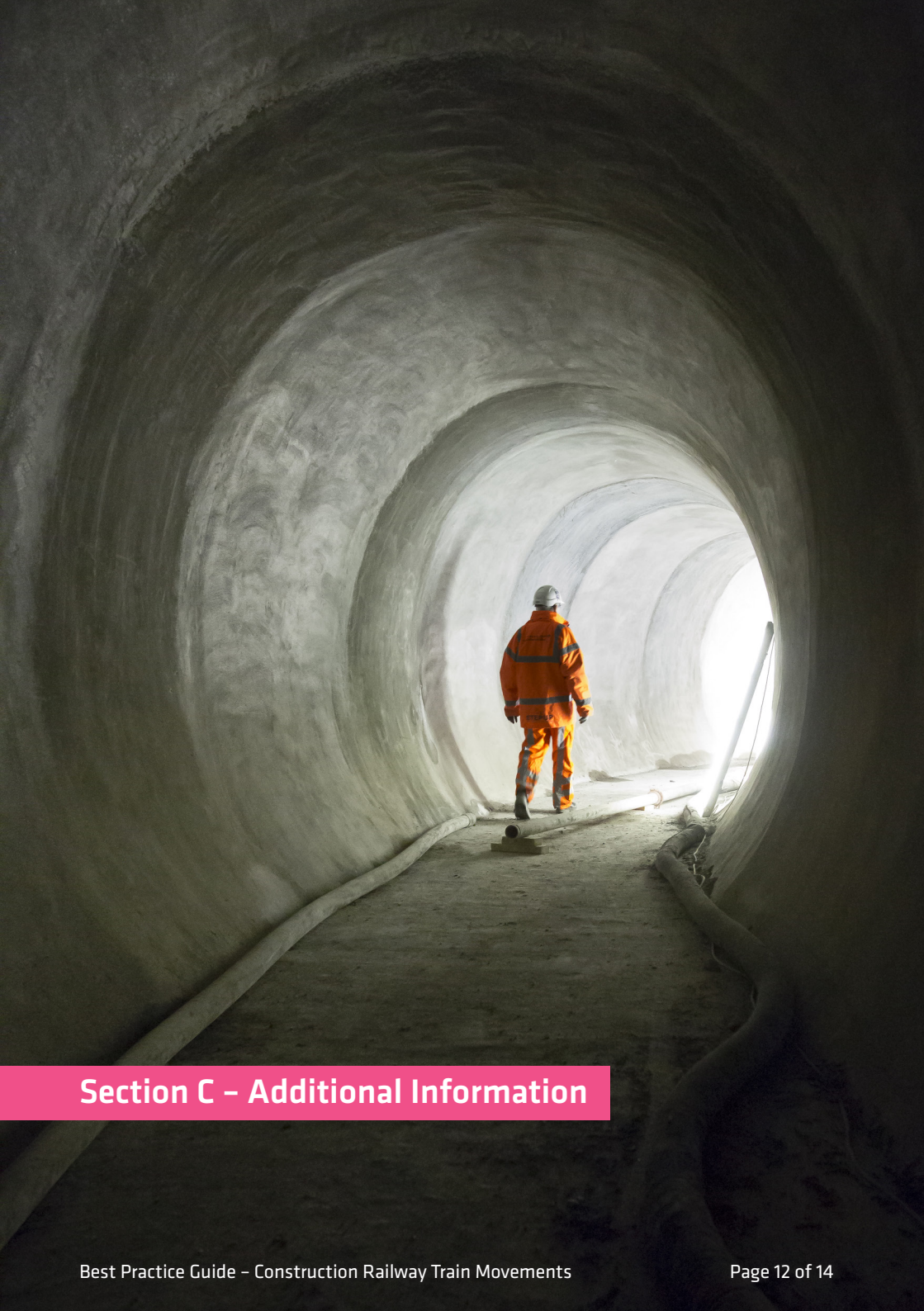


## Mucking Cycle:



## Spraying Cycle:





## Section C – Additional Information

## Section C

# Additional Information

### Communication

The following methods should be used to communicate the necessity and operation of Exclusion Zones and Restricted Areas to all personnel within the tunnel whether working in the tunnel for any reason, or a visitor. All communication should be through properly inducted and competent personnel:

- All inductions
- Toolbox talks
- Shift briefings to operatives and staff working in the tunnel
- Site visitor briefings to all other visitors
- Record site specific requirements on RESS where appropriate and would not affect clarity of RESS

Visible and protected (e.g. laminated) display boards depicting the Zones and Areas clearly and graphically (see Appendix for example). These boards should be at least A1 size and located close to the boundary between the Exclusion Zone and the Restricted Area, and at the entry to the Restricted Area.

At any time that an area changes from an Exclusion Zone to a Restricted Area, or from a Restricted Area to an Exclusion Zone, the Exclusion Zone Supervisor must ensure that all barriers are appropriately set-up and that personnel undertaking tasks close to the exclusion zone are notified and aware.

### Further Measures

CCTV monitoring systems at the face should be used at all SCL locations unless agreed by the CRL PM and Contractor PD that they are not appropriate in that location.

The following additional measures should be considered and adopted where appropriate:

- The use of thermal imaging technology to support the strength testing and time restrictions and to search for local cold spots in inaccessible areas that can not be examined by penetrometer testing
- Traffic light systems or boards to reinforce the physical barriers used, particularly at the boundary between the Normal Access Zone and the Restricted Area

## Glossary of terms used in this Guide

<b>CCTV</b>	Closed Circuit Television
<b>CRL</b>	Crossrail Limited
<b>PD</b>	Project Director
<b>PM</b>	Project Manager
<b>SCL</b>	Sprayed Concrete Lining

## External standards that support the use of this Guide

<b>BS 6164:2011</b>	Code of practice for health and safety in tunnelling in the construction industry
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## Phonetic alphabet

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

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

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



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