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Foreword

With significant investment planned for stations across the network, it is important that the industry adopts a consistent approach to the planning and design of our stations.

In the past decade, the number of rail passengers has grown by 50 percent and stations like London Waterloo and London Victoria now handle more people per day than the UK’s busiest airports. However, until recent years, there has not been any new major infrastructure and many of our stations are busier than ever.

Since Victorian times, our railway hasn’t just moved passengers and freight; it has generated, and spread, prosperity. That is why we are continuously investing in our network with several high profile schemes such as Thameslink, Crossrail, Edinburgh Glasgow Improvement Programme and Northern Hub. Station upgrades and new facilities will play a key role in delivering these schemes and helping to increase capacity, safety and passenger comfort. The importance of stations in delivering a better railway is clearer than ever.

Modern stations are the shop windows of our railway. In addition to providing access to train services our stations are used as meeting places and provide opportunities for retail and leisure. Passengers expect, and deserve, a positive experience at stations as part of their overall journey on the railway. Ease of access, readily available travel information and ambient station space will improve passenger satisfaction and the attractiveness of rail as a mode.

With significant investment plans for stations across the nation, it is important that the industry adopts a consistent approach for planning and design of station environments.

This document provides a series of best practice guidelines for the design and planning of railway stations to guarantee that we continue to deliver value for money and excellent passenger experience across the network.

Isabelle Milford
Station Capacity Manager
Executive Summary

This document provides guidance for undertaking capacity assessments for stations across the network. It stipulates the thresholds for planning and design of passenger areas with a consideration for ‘value for money’.

The guidance shall be used by all parties involved in the station design process including, but not exclusive to, Network Rail staff, architects, train operating companies (TOC) and engineering and planning consultants.

The application of this guidance ensures station design supports the Industry and Network Rail’s objectives, namely:

- Develop and maintain consistently high performing stations that support safe movement of passengers and customer satisfaction
- Deliver station improvements and designs that are fit for purpose, cost effective and sustainable.

This guidance provides the information required by architects and designers to produce an outline station design focussing on public areas. It includes all calculations required to assess whether a station meets Network Rail’s aspirations regarding passenger comfort and safety in the station environments, during normal operations and emergency/perturbation situations.

It also provides a good practice guide for undertaking capacity assessments. This information is relevant for those responsible for station capacity assessment studies and contains the Network Rail requirements with regards to analysis and deliverables.

This document supersedes the previous version published in May 2011. The guidance will be periodically updated to reflect ongoing research, consultation and changes in legislation and shall be read in conjunction with:

- Station Design Principles for Network Rail Guide, March 2015
- Design Standards for Accessible Railway Stations, Department for Transport and Transport Scotland, March 2015
- Other Rail Industry Standards and Building codes referred to in Appendix F

Queries or comments regarding this document are welcomed and should be sent to: stationcapacity@networkrail.co.uk.
1 The Overview

Introduction to the basic principles of spatial planning for public areas and Network Rail’s planning criteria.

This guidance applies to the spatial aspects of station planning for public areas during normal operations and abnormal conditions. Requirements for staff accommodation and areas that are only used by tenants are not covered in this guidance.

It is important to understand that the capacity requirements included here shall be treated as a minimum. Depending on the project aspirations it may be desirable to deliberately design public areas in excess of the spatial requirements outlined here.

The following chapters provide methods for sizing public areas that have sufficient space to allow unimpeded circulation of passengers, and also for reasonable comfort in waiting areas.

The Fruin levels of Service (LoS) specified here relate to Network Rail’s aspirations of providing adequate level of comfort without making stations uneconomically large. These guidelines are applicable to existing and new stations. Station layouts shall always be assessed in relation to the peak usage that is either based on a survey or predicted future demand.
Passengers have different needs and behave differently within any given station environment (see Figure 1-2). They walk at different speeds on flat and stepped surfaces. For example, most passengers walk at speeds between 0.6 to 2.0m/s on flat surfaces in free-flow conditions. An average adult may walk at a speed of 1.5m/s or above on flat surfaces in normal conditions. In crowded conditions however, the walk speeds are significantly lower.

Passenger demand shall be classified into the following categories. Analysts shall consider site specific factors that may affect passenger demand and diversity e.g. availability of step-free access, stations connecting to airports or stations near hospitals. Such assumptions shall be agreed with the Network Rail’s Station Capacity Team (NR SCT).

Commuters are normally travelling to and from work or place of study and are familiar with the station layout and train services. At most stations, a large proportion of passengers during the peak periods are regular commuters.

Leisure travellers are infrequent users of the railway; may require assistance in terms of wayfinding and train information. They generally tend to arrive at the station earlier, and hence dwell longer in comparison with regular commuters. At some stations, a large proportion of users can be of this type on a Friday afternoon and at weekends or during special events. They may also carry some form of luggage.

Passengers in wheelchairs need step free access and may require assistance in accessing train services or other facilities at a station.

Passengers with reduced mobility may have a physical or cognitive condition which affects their ability to navigate within a station environment. Such passengers require more space, time or even staff assistance.

Passengers with luggage require more space depending upon the size and shape of luggage they are carrying. This includes passengers carrying small rucksacks, large shopping bags, large musical instruments, regular or fold-up bikes and large suitcases.

Passengers with young children and infants in pushchairs may be slow-moving and prefer to remain in groups.

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1 The passenger walk speeds quoted here are based on anecdotal evidence gathered from various stations on the National Rail network. These are consistent with the passenger walk speeds observed by Transport for London at London Underground stations.
2 Undertaking Capacity Assessments

Guidance for analysts and other parties involved in scoping and producing capacity assessments studies.

2.1 Identifying the need for an assessment

Station capacity assessments shall be undertaken for the design and planning of all new railway stations and for schemes that affect the usage and flow of passengers in station environments. For any scheme, consideration shall be given to the station layout, volume of passengers and complexity of movement, GRIP (Governance for Railway Investment Projects) stage and the level of intervention. Particular consideration shall be given to station category\(^2\), strategic importance along the Route or within the local area.

The objectives of an assessment may typically include:

- Benchmark existing station performance
- Optimise station layouts
- Option selection and design development
- Evidence for a business case
- Test crowd management, construction impact and evacuation plans
- Evaluate the impact on passengers due to changes in timetables, introduction of new services or rolling stock

NR SCT shall be consulted at the earliest opportunity in order to identify the need of an assessment and to help define a remit.

2.2 Remits

A remit shall clearly set out the following with respect to the assessment that is required:

- Context, the strategic fit and the problem statement
- Objectives of the study\(^3\), scope, interdependencies
- Indicates any gaps in availability of passenger and train information
- Operational and other assumptions
- Programme milestones and deadlines.

Remits shall be developed by the Client, Sponsor or Manager in conjunction with, or reviewed by, the NR SCT. Following on from this, a proposal will be provided by the NR SCT or an external consultant.

\(^2\) Better Rail Stations, November 2009.

\(^3\) Clearly set out what is expected from the assessment i.e. what are the questions that need answering.
2.3 Proposals

The NR SCT or an external consultant shall respond to the remit with a project proposal. This proposal shall be sent to the Client, Sponsor or Manager and reviewed by the NR SCT.

It is important that respondents understand the objectives and various stages of an assessment to develop a comprehensive proposal.

Each proposal shall demonstrate:

- Good understanding of the remit, the context, ability to identify key areas that need to be analysed and any constraints.
- Strong capability in the discipline and selection of an appropriate method for analysis based on site complexity.
- Detailed cost and resource breakdown demonstrating value for money.
- Project plan showing alignment with wider NR delivery programme.
- Allowance for review and feedback from NR SCT throughout the project.

The Client, Sponsor or Manager will approve and initiate an assessment project once the NR SCT has completed a technical and capability review of the proposals.

2.4 Demand forecasts

A vast majority of station users are rail passengers, but some stations also offer a variety of retail, attracting a significant number of visitors who are not rail users. Some stations may also provide access to other transport modes, such as trams or metro services. A station may also generate footfall by offering a short-cut between two external locations and hence it may be necessary to include such non-rail background demand; e.g. the new concourse at Birmingham New Street station connect two sides of the city centre.

Capacity assessments shall at least consider an interim and future year scenario. Any profiling of passenger demand across the peak in relation to train loadings shall be agreed with NR SCT.

Network Rail Economic Planners can provide demand forecasts based on Route Studies and other forecasting tools used in the industry. Forecasts developed by a consultant or another organisation will need agreement with the Network Rail Economic Planners at the start of any assessment project.
2.5 Data requirement and collection

Wherever possible, surveys shall be commissioned to establish a good understanding of passenger numbers in and around stations and any station specific characteristics in relation to train services, interchange and operational controls. Data requirements may vary based on the scope of the assessment and project objectives.

Network Rail Project Managers shall review the checklist in Appendix A, to identify if the required data is readily available and start sourcing this information from Network Rail studies, train operating companies, Local Authorities, Transport for London, Merseyrail or other third party developers.

Any gaps in the data shall be clearly defined in the remit. In all cases, NR SCT shall be consulted to determine the suitability of using existing data. Appendix A includes a brief description of the different datasets required and suggested methods of data collection.

NR SCT can organise surveys if required. Where surveys are being commissioned by consultants the proposed methodology and scope will require approval from the NR SCT and the Station Manager. It is important that careful consideration is given to the planning and safe operations during any survey.

2.5.1 Passenger and train data

A survey shall cover two morning and afternoon weekday peaks (e.g. 0700 – 1000 and 1600 to 1900hrs) and any other times when passenger volumes are known to be high. Validation counts and observations shall be made to ensure consistency in the data that is collected. At some stations it may be necessary to include other times during weekdays and weekends depending on the project objectives and station usage.

For new stations, demand data may come from forecasting models and the suitability of such forecasts and underlying assumptions shall be discussed with the NR SCT.

2.5.2 Station layout and operations

All assessments require an accurate definition of the physical layout of the station being assessed; typically this information shall be in electronic CAD format.

The configuration of existing infrastructure such as escalators, ticket barriers and station entry gates shall be observed and included in the analysis.

Passenger behaviour in relation to concourse dwelling, train announcements, location and format of CIS (customer information screens), wayfinding and crowd management measures such as ‘keep left / right’, one-way routes shall be considered in assessments.
3 Space Requirements for Normal Operation

The space requirements specified in this section are based on specific planning criteria for each type of station element for normal operating conditions. The methods described here ensure that adequate level of comfort is achieved in public areas of stations without making them uneconomically large.

3.1 Passenger demand concepts

Station capacity assessments shall be based on passenger demand from the busiest time periods. At most stations the busiest times are normally the morning and afternoon peaks as passengers travel to and return from work.

In some cases a separate assessment for weekends and special events may be required. Special events require management controls and may involve queuing passengers in a safe environment. This can have a direct impact on space requirements in and around stations.

Non-rail users shall be included where applicable i.e. demand associated with station retail and thoroughfare.

The passenger demand used in assessments shall be based on survey data and relevant forecasts. Network Rail Economic Planners shall be consulted regarding demand forecasts.

The following concepts of demand data are used in this document:

**Total number of exiting passengers** shall be derived using the alighting loads from the maximum possible number of trains that arrive during the busiest 5-minute period on a typical day. The busiest train shall have its alighting load increased by 25% to factor in delays to the service.

**Non-rail demand** shall be included for stations where this may be appropriate. This may be driven by retail footfall, access to other transport modes and thoroughfare.

**Peak minute flow** shall be derived from count data collected at the station being assessed. Where data of this resolution is not available, a reasonable assumption shall be made regarding the spread of passenger demand based on the following:

*For entry flows* the peak minute flow shall be estimated by applying a factor of 0.2 to the observed peak 5-minute flow.

*For exit flows*: i.e. flows away from platforms the peak minute flow shall be based on observations made on site. In most cases the concentration of alighting passengers will depend on the length of trains, stock formation and the station layout. A reasonable percentage shall be applied to the peak alighting load from the maximum number of trains that arrive concurrently within the busiest 15 minutes.
The following ranges in Table 3-1 can be used as a guide to make an assumption about the concentration of demand within the peak minute. This method is useful to ensure that station elements are not over-designed unnecessarily e.g. calculating the width of stairs connecting the platforms with a footbridge.

Nb: These values differ for every station and shall be derived from site observations. Platform furniture and other constraints may further limit the flow of passengers away from some platforms.

Adjustments to peak minute flows

At some stations passenger flows may be constrained by the physical capacity of one or more circulation elements. For example, an escalator would regulate the flow of passenger into a connected walkway. In such situations it is important that these flow-rate constraints are considered in determining the peak minute entry and exit flows to avoid unnecessary overdesigning of station elements.

Nb: Such adjustments based on train length (Table 3-1) and circulation constraints shall only be used for access and interchange infrastructure. Refer to exceptions in Section 3.2.1 for such adjustments specifically included for gateline calculations.

<table>
<thead>
<tr>
<th>Train length</th>
<th>Recommended concentration of demand in peak minute</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 4 car services</td>
<td>80 – 100% of maximum alighting demand</td>
</tr>
<tr>
<td>4 to 8 car services</td>
<td>60 – 80% of maximum alighting demand</td>
</tr>
<tr>
<td>8 to 12 car services</td>
<td>50 – 60% of maximum alighting demand</td>
</tr>
</tbody>
</table>

Note: These values differ for every station and should be derived from site observations. Platform furniture and other constraints may further limit the flow of passengers away from platforms.
3.2 Revenue protection

Different types of ticket gates are used at stations across the network, varying by manufacturer and dimensions. Table 3-2 lists the recommended throughputs by type of gate and operation for calculating the number of ticket barriers.

<table>
<thead>
<tr>
<th>Gate Type</th>
<th>Method of Operation</th>
<th>Recommended Throughput (f value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard ATG</td>
<td>Uni-directional</td>
<td>25 per minute</td>
</tr>
<tr>
<td>Wide Aisle Gate</td>
<td>Uni-directional</td>
<td>12 per minute</td>
</tr>
<tr>
<td>Wide Aisle Gate</td>
<td>Bi-directional</td>
<td>7 per minute</td>
</tr>
</tbody>
</table>

*Note: Check with NR SCT if a non-standard throughput is more appropriate based on manufacturer information or observations from an existing gateline. 

Each gateline array shall be capable of accommodating the forecast passenger demand and shall include wide aisle gates (WAG) to allow passenger with luggage or reduced mobility to pass through.

Where WAG usage forecasts are not available the number of WAGs shall be apportioned based on the number of standard ATGs provided in each gateline array as shown in Table 3-3.

More WAGs are required at some stations depending on passenger demographics, location of gateline in relation to step-free access routes and destinations served by a station (e.g. airports and long distance rail travel).

In case WAG usage is known then the following calculation shall be used with an appropriate f-value as per Table 3-2.

3.2.1 Calculating the number of ticket gates

The formula for calculating the required number of gates in a gateline is split into three parts. An appropriate f-value shall be applied from Table 3-2 to calculate requirement for each type of ticket gate.

1. First part calculates the number of gates needed for the entry flow.
2. Second part calculates the number of gates needed for the exit flow.
3. Third part of the formula adds either one or two additional gates to the combined number of entry and exit gates calculated in parts one and two.
Where:

**Peak 5-minute entry flow** is the maximum number of passengers entering the station to board one or more train services departing within the peak 5-minute period. This shall be based on survey data and forecast growth including a 25% mark-up applied to the busiest train boarding load as per Section 3.1. At stations where headways are typically less than or equal to 5 minutes, all passengers boarding trains departing in the peak 5-minute period shall be assumed to pass through the gates in the same 5 minutes.

It must be noted however, at stations where trains dwell longer (e.g. at termini), a reasonable assumption shall be made regarding the spread of passengers passing through ticket gates at peak times to board one or more trains. This is because some passengers may choose to pass through the gates more than five minutes before their train departs. This generally depends on the anticipated transfer time from the gateline to a specific location on platforms, time when train doors close and specific passenger characteristics (e.g. some long distance trains have long turnaround times).

**Total number of exiting passengers** shall be derived using the maximum number of passengers exiting a station from one or more train arrivals. This shall be based on individual train alighting survey data or forecasts numbers, and the maximum possible number of trains that can possibly arrive at a station concurrently during peak periods. A mark-up of 25% shall be applied to the busiest train alighting load as per Section 3.1.

All calculations shall use the entry and exit flows from the same 5-minute time period. If the forecast entry and exit flows are not available, it is recommended that at least 20% increase is applied to the current demand.

**n-value** for stations with through platforms shall not be greater than 2 minutes and a value up to 4 minutes can be used for gates located at the head of terminating platforms. This value is only used in static calculation to spread the total number of exiting passengers over a reasonable period of time to avoid over-specifying the number of exit gates. The recommended thresholds for the n-value are a function of the desirable platform clearance time at stations. The n-value shall be agreed with the NR SCT on a case by case basis.

If the total number of ticket gates (including X) calculated using this formula in a single gateline is less than 3 ATGs, then at least 3 ATGs shall be provided with additional WAGs as per Table 3-3.

---

*At termini the gap between arrivals on multiple platforms are generally longer, whereas at some through stations the headways can be as small as 2 minutes.*
The formula shall be used twice, once to calculate the number of gates needed in the AM peak and then again to calculate the number of gates required in the PM peak. If a station has a high number of leisure travellers (i.e. tourists and shoppers) then the busiest period of gateline activity may be outside the AM and PM weekday peak times, in which case a third calculation for the number of gates shall be undertaken. The highest figure from all calculations shall be used as the required number of ticket gates.

**Exceptions to the use of this formula**

If a gateline is separated from the platforms by any kind of intermediate constraint\(^6\); e.g. an escalator, staircase, footbridge or passageway, the flow of exiting passengers will be limited by the capacity of this element of infrastructure. In such cases the total number of exiting passengers used in the above formula shall be adjusted to represent the maximum number of passengers that could possibly arrive per minute at the exit gates in a constrained flow scenario. For calculations based on this method, the \( n \)-value shall be set to 1 minute.

### 3.2.2 Paid and unpaid run-off areas

Clear space is needed on either side of gates to accommodate the momentary gathering of passengers at ticket gates. The calculation is based on a space provision of 0.45m\(^2\) per person (queuing LoS D). This is to ensure that entering and exiting passengers do not impede circulating and interchange movements on either paid or unpaid sides of the gateline.

If the clear run-off value based on this calculation is less than recommendations in Table 3-8 then the higher value shall be used.

Maximum queuing passengers in the formula shall be derived using:

1. 60% of the average peak exit flow based on the 5-minute exit flow and \( n \)-value (minutes) used in exit gateline calculations\(^7\)
2. 60% of the average 1 minute entry flow based on the 5-minute entry flow used in the gateline calculations.

\(^6\) This is only applicable when using peak minute exit flows recorded in dynamic simulations to replace ‘total exiting passengers’ in the formula.

\(^7\) The use of 60% exit flow is based on the assumption that alighting passengers will at least take two minutes to pass along the platform and arrive at the gates.
**These percentage values may be adjusted based on station layout, passenger behaviour and type of train service.**

Where ticket gates are separated from the platforms by an intermediate constraint; e.g. a staircase, maximum possible entry and exit movements per minute based on the capacity of circulation infrastructure and train arrivals/departures shall be calculated.

### 3.2.3 Gateline orientation

Gatelines shall be sited such that all gates are readily accessible, and entry or exit gates shall be grouped in larger arrays, to minimise cross flows. For large gatelines serving multiple terminating platforms, it may be more appropriate to alternate such clusters of entry and exit gates along the length of the gateline. In such cases it is beneficial to clearly mark the clusters with dynamic overhead signage that can change when the directional setup gates is reversed.

Ticket gates shall not be placed on platforms. Gatelines located on platforms may increase platform clearance times and result in queues as passengers wait to pass through the gates. In many cases this may severely impede platform circulation, forcing passengers to pass closer to the platform edge, potentially posing a safety risk. If a feasible alternative cannot be found, a risk assessment shall be undertaken.

### 3.2.4 Gateline equipment and other considerations

There are other pieces of equipment, relevant to some stations, see below. The installation requirement of such equipment shall be assessed on a station by station basis.

- An equipment gate to allow mobility buggies, machinery or servicing vehicles to pass through between paid and unpaid sides
- Gateline Attendant’s Point (GLAP), or other place of safety for the gateline staff
- A control unit to facilitate remote operation of the gateline and to allow for all gates to be opened in an emergency
- Smart card readers

The gateline position, number of barriers and run-offs shall be assessed for emergency evacuation scenarios (see section 4.4) to ensure there is no impediment to passenger egress. A throughput of 40 passengers per gate per minute shall be used to calculate one-way egress capacity. It shall be assumed that all gates will remain open during emergency conditions. Note that the evacuation plan may require certain arrays to remain closed to assist staff in preventing passengers from entering zones that are being evacuated.
3.3 Platforms

Platforms have to accommodate passengers transferring to and from train services as well as those using the area as a route to access other parts of the station building. It is therefore important that they are designed to allow free circulation whilst also preserving good lines of sight.

All platforms shall meet the recommended minimum widths listed in Table 3-4.

<table>
<thead>
<tr>
<th>Table 3-4 General principles for platform sizing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platform width</td>
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<td></td>
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<tr>
<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Columns and other obstructions</td>
</tr>
<tr>
<td>Headroom</td>
</tr>
<tr>
<td>'Yellow Line'</td>
</tr>
</tbody>
</table>

---

8 Table 3-4 is based on Railway Safety Principles and Guidance, Part 2b, ORR and the Railway Group Standard GI/RT/7016, RSSB.
Calculating the required platform width

To ensure correct sizing of platforms one of the two methods described below shall be used to calculate the required width depending on station operation and platform usage. If it is not possible to deliver the required width based on this guidance, a risk assessment shall be undertaken.

In case of island platform the same calculation needs to be repeated for both operating sides of the platform.

Stations where passengers wait on platforms

Passengers are likely to proceed directly to a platform and wait there for their train at stations with dedicated platforms for trains to different destinations or routes.

For such platforms the required width shall be determined by combining individual widths for the following zones:

A. **Yellow Line Zone** is a safety requirement to mitigate the risks of aerodynamic effect from passing trains at some stations and commonly used in dispatch operations.

B. **Boarding and Alighting Zone** shall accommodate all boarding and alighting passengers at a density of 0.93m$^2$ per person (queueing LoS B/C).

C. **Circulation Zone** shall allow circulating passengers to walk through un-impeded at a maximum flow rate of 40 passengers per minute (walkways LoS C).

D. **Activity Zone** accounts for platform furniture, footprint of vertical circulation infrastructure, station buildings and retail.

![Diagram](image-url)
The positioning of passengers on a platform is not always uniform and is influenced by:

- Location of platform entrances
- Any shelters or canopies
- Preferred carriage based on exit point at the destination station
- Location of CIS (customer information screen) displays
- Knowledge of busiest carriages
- Seat reservations in some cases

To account for this uneven platform loading the calculations for zones A – D shall be carried out by dividing the platform length into ‘carriage blocks’ which correspond to individual train cars. The required width shall then be calculated for each ‘carriage block’ separately using the formulas for zones A – D; e.g. for an eight car train eight separate platform widths would be defined.

Ideally platforms shall have a uniform width and the maximum width calculated for the busiest carriage block shall be used. Where this is not the case a risk assessment shall be undertaken, with supporting calculations, to demonstrate that any risks are as low as reasonably practicable.

The following calculations shall be carried out for the busiest periods and for all different train lengths that call at the platform; e.g. some rolling stock formations may result in higher concentration of passengers within a relatively small part of the platform.

Zone A: Yellow line zone
A ‘yellow line zone’ shall be provided based on the minimum requirements listed in Table 3-4. For stations where a yellow line zone is not provided, a minimum 0.5m shall be added to the calculated width.

Zone B: Boarding / Alighting zone
The zone used by boarders and alighters can be calculated by the following formula separately for each carriage block:

**Calculating size of boarding and alighting zone**

\[
\text{boarding / alighting zone} = \left( \frac{\text{block load} \times 0.93}{\text{block length}} \right) \text{ m}
\]

Where:

- The block length is the length of each carriage based on the appropriate rolling stock.
- Block loading is the maximum number of passengers that board and alight the individual train car located within the ‘carriage block’. Distribution of boarding and alighting passengers along the length of a platform shall be based on a survey of the number of boarders and alighters for each train car.

In case platform spreading information is not available a reasonable assumption shall be agreed with the NR SCT.
Zone C: Circulation zone

The space required for other circulating passengers to pass along the platform shall be based on the following formula:

\[
\text{Width of circulation zone} = \left\{ \frac{\text{peak 5 min flow}}{5 \times 40} \right\} \text{ m}
\]

Where:
The peak 5-minute flow refers to passengers using the platform that are not accounted for in the boarding and alighting demand when calculating Zone B. This shall be based on survey data but if this information is not available a reasonable assumption shall be made. At stations where such circulating movements do not occur, a circulation zone is not required.

Zone D: Activity zone

A minimum allowance of 0.3m shall be added to the calculated platform width for an ‘activity zone’. The width of this zone shall be increased to take into account platform furniture, footprint of vertical circulation infrastructure, any station buildings and retail located within each individual ‘carriage block’.

All four calculated widths shall be added together to calculate required widths for each ‘carriage block’. These shall be adhered to when designing, or making amendments to, the station.

Stations where passengers wait on the concourse

The space requirements are different for stations where passengers normally dwell in a concourse area until their train gets announced.

\[
\text{Platform width where passenger wait on concourse} = \left\{ \frac{\text{peak minute flow}}{40} + 0.5 \right\} \text{ m}
\]

Where:
Peak minute flow is the maximum two-way flow passing along the busiest section of the platform including any circulation demand to other areas. A minimum edge-effect of 0.5m is included. This value shall be increased as per Table 3-4 for platforms where a ‘Yellow Line’ zone is required for safety reasons.

If detailed demand data is not available, 60% of the maximum alighting load\(^9\) from the longest arriving train(s), plus 20% of the maximum boarding demand shall be used in the formula as the peak minute flow.

\(^9\) The use of 60% of the alighting load is based on the assumption that alighting passengers will at least take two minutes to pass along the platform. It shall be assumed that the boarding load is evenly spread over 5 minutes unless evident otherwise.
3.4 Canopies

Canopies shall be provided over platforms and other public areas within a station to provide weather protected route to and from train services. This is to ensure safety and improve passenger comfort during inclement weather conditions. Insufficient shelter results in congestion as passengers congregate in covered areas. This slows boarding and alighting and has a negative impact on train performance.

It may not always be possible to provide sufficient canopy cover due to heritage issues, physical constraints on-site or very low station usage. In such cases the possibility of installing separate sheltered waiting areas shall be explored as shown in Figure 3-2.

Where a canopy is provided it shall give adequate cover on platforms so that boarding and alighting operations are not compromised during inclement weather conditions.
3.4.1 Calculating canopy size

The recommended area covered by a canopy shall be calculated by taking the maximum value from one of the two approaches below.

1. The first calculation is based on the number of doors that are needed to be under canopy cover to meet the train dwell time requirement. One shall then relate this to the rolling stock that is used to calculate the length of canopy cover in metres.

   Number of carriage doors under cover

   Where:
   The maximum boarding load is for the single busiest train service on each platform. The train dwell time used here refers to the time when train doors remain open in 'normal' running.
   Note that doors and not always evenly spaced and locations can vary by type of rolling stock. If door widths vary on a single carriage then an average door width shall be used for the length of the train.

   A throughput of 40 passengers per minute per metre width of train doors is assumed here in the formula and this value can be reduced if deemed appropriate for a given site.

2. The second calculation is for the space (m²) that is required on a platform to accommodate the maximum number boarders at a reasonable density level. One shall then derive the canopy length (metres) by considering the usable width along the platform.

   Platform dwelling area under cover

   \[ \text{area under canopy} = \left( \text{maximum boarding load} \times 0.65 \right) \text{ m}^2 \]

   Where:
   The maximum boarding load use here is for the single busiest train where headways are longer than 5 minutes. In case of shorter headways all boarders for the first train and those waiting for subsequent trains shall be used in the calculation.

   A passenger density of 0.65 m² per person (queueing LoS C/D) is used in this calculation and a lower density level can be used if deemed appropriate for a given site.

   Any station buildings or areas covered by platform furniture that cannot be used by passengers waiting for trains shall be excluded from both calculations.

   Other factors influencing the spreading of passengers on platforms shall be considered when designing canopies. These may include the location of platform access routes, passenger behaviour and train loadings.
3.5 **Concourses**

The main function of a station concourse is to provide sufficient space for passengers moving through and waiting within it. These capacity requirements provide guidance on how to ensure the concourse size is appropriate for the level of passengers utilising the area.

3.5.1 **Calculating concourse size**

Concourses shall be large enough for passengers to move through without experiencing excessive congestion or obstructions. Unpaid concourse areas shall be designed to a density level no greater than walkway LoS C (1.8m² per passenger), to account for the complex movements that occur in these environments. This allowance is over and above any space required for run-off or queuing areas as shown in Figure 3-3 (see Table 3-4 and Table 3-7 for queuing space and run-off requirements).

Concourse area is calculated by using the following formula:

$$\text{concourse area} = \left( \frac{\text{peak 15 minute flow} \times 1.8}{15} \right) + A \text{ or } B \text{ m}^2$$

Where:

The peak 15-minute flow shall consist of all passengers moving through the unpaid concourse area; both entering and exiting passengers, plus non-rail users.

**Area A**

At stations with dedicated platforms for each direction or service type, passengers are likely to wait on the platforms rather than the concourse. At these stations an allowance still needs to be made for those passengers who stop to view CIS screens in the concourse area. This area shall be large enough to accommodate 10% of the peak 15-minute station entry and exit demand at a density of 1.0m² per person (queuing LoS B).

**Area B**

At stations where passengers predominantly wait in the concourse area and access the platforms only after their train has been announced, a larger accumulation area is required for waiting passengers. This accumulation area near the CIS shall be designed to be large enough to accommodate 100% of the peak 15-minute station entry demand at a density of 1.0m² per person (queuing LoS B).
3.5.2 Concourse configuration

Station concourses shall aim to

- Provide clear sight lines
- Be devoid of clutter and unnecessary obstacles
- Have clear signage
- Provide CIS areas that compliment overall station way-finding
- Avoid convoluted routing
- Keep passenger desire lines clear

It is important to consider these when planning the layout of concourses so that as well as having the correct amount of floor space, the space that is provided promotes ease of movement through the station.

The space occupied by retail units, ticketing and information facilities and gatelines is not included in the calculated concourse space (see Figure 3.3).
3.5.3 **Additional concourse space requirements**

Table 3-5 sets out the queuing space required for various elements that may feature in a station concourse in addition to the calculated concourse space based on formula stipulated in Section 3.5.1.

3.5.4 **Station entrances and approaches**

Station entrances and the curtilage shall be designed to accommodate station related flows, other background movements in the urban realm and allow for future rail and background growth. Station entrances are often meeting points and generous space provision is required.

The sizing of entrances and forecourt areas is important and shall be discussed with the NR SCT on a case by case basis. This needs consideration for normal and degraded modes of operation as well as strategic placement of links to other travel modes such as trams, metros, buses, taxis, car and cycle parking.

Any bottlenecks in the station periphery, outside of railway land, shall be jointly addressed with the relevant local authorities and businesses.

Diversity Impact Assessments\(^\text{10}\) shall inform the step-free access requirements. A consideration shall be made for weather protection and security.

<table>
<thead>
<tr>
<th>Station facility</th>
<th>Space requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ticket machines</td>
<td>Queuing space of 4.0m in front of each ticket vending machine that is free from obstructions and circulating movements. Queuing systems may be used if necessary.</td>
</tr>
<tr>
<td>Ticket office</td>
<td>Queuing space of 4.0m in front of each ticket issuing window that is free from obstructions and circulating movements. Queuing systems may be used if necessary.</td>
</tr>
<tr>
<td>ATMs</td>
<td>Queuing space of 4.0m in front of each ATM that is free from obstructions and circulating movements. Queuing systems may be used if necessary.</td>
</tr>
<tr>
<td>Retail, food and refreshment outlets</td>
<td>Space for such facilities should be provided in addition to the general requirement for passenger movement. Any queuing space or seating arrangement associated with food and refreshment outlets should be calculated separately.</td>
</tr>
<tr>
<td>Other facilities</td>
<td>Space requirements for customer information points, waiting rooms, left luggage, lost property, public toilets and baby changing facilities should be calculated separately if included in the design.</td>
</tr>
</tbody>
</table>

\(^\text{10}\) Spaces and Places for Everyone, Network Rail Inclusive Design Strategy, 2015
3.6 Access and interchange

Access and interchange routes provide the means for passengers to move around the station between the external, concourse and platform zones. They consist of passageways, escalators, passenger conveyors, stairs, lifts and ramps. Access and interchange routes shall be clear, safe, direct and compliment the station way-finding strategy.

This section provides the recommended requirements for access and interchange infrastructure. It is recognised that at existing facilities or constrained sites it may not be possible to meet these specifications. Where this is the case, a site specific risk assessment shall be undertaken.

3.6.1 Passageways

It is recommended that the minimum width for any passageway is 2.2m. This takes into account a minimum width of 1.6m between wall finishes and an ‘edge effect’ of 0.3m for each side.

Where a central handrail is provided to separate passenger flows, the minimum width either side of this shall be 1.6m plus an edge effect of 0.3m for the wall on one side. No edge effect shall be associated with a central handrail; although the width of the rail itself shall be accounted for. E.g. a passageway measuring 3.8m with a 0.2m handrail would be below the minimum requirements.

The above widths are only applicable in cases where the calculated widths based on passenger demand are lower than this minimum standard requirement.

The formulae below shall be used to calculate the required passageway widths for one-way and two-way flows. One-way flows are based on Fruin walkway LoS D and two-way flows are based on walkway LoS C.

An ‘edge effect’ of 0.3m is added to each side of the passageway to account for the space passengers leave to avoid touching the walls. No edge effect is applied to central handrails.

Calculating passageway widths

\[
\text{two-way passageway width} = \frac{\text{average peak minute flow}}{40} + (2 \times 0.3) \text{ m}
\]

\[
\text{one-way passageway width} = \frac{\text{average peak minute flow}}{50} + (2 \times 0.3) \text{ m}
\]

---

3.6.2 Passenger conveyors

If it is commercially viable and beneficial to do so, passenger conveyors can be installed in a number of locations including along passageways. These can be considered when station layouts have large walking distances. It shall be assumed that passenger conveyors or travelators have the same run-off requirements as escalators. The manufacturer’s specification shall be used to determine a throughput rate for capacity calculations.

3.6.3 Vertical circulation elements

Notwithstanding the need to provide ‘step-free’ access throughout station environments, all new station designs shall include at least one step-free route from street to concourse and from concourse to platforms. Diversity Impact Assessments must be undertaken to determine the appropriate step-free access solution for each station.

Different means of vertical circulation shall be used in stations depending on the level changes stipulated in Table 3-6. This is to improve passenger circulation and comfort.

<table>
<thead>
<tr>
<th>Level Change</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 0.5m</td>
<td>Ramp</td>
</tr>
<tr>
<td>0.5m to 3.0m</td>
<td>Stairway</td>
</tr>
<tr>
<td>3.0m to 5.0m</td>
<td>Stairway or escalator if the benefits are justifiable</td>
</tr>
<tr>
<td>More than 5.0m</td>
<td>Escalators or lifts</td>
</tr>
</tbody>
</table>

Note that this is only a guide and it may be appropriate at some stations to exceed these minimums. For example, there may be capacity benefits and a business case to install escalators for a change in level of less than 5.0m.

Generally, although not always possible, no single escalator or lift shall provide the sole means of changing level. This is to take into account resilience for routine servicing of asset and passenger accessibility.

Ramps

The width of a ramp shall be calculated using the following steps:

- Gradient less than 1 in 20, the same way as for a passageway
- Gradient greater than 1 in 20, the same as for a passageway but with a 10% reduction in the flow-rate shall be assumed

The minimum clear width shall be 1.5m with sections that are 1.8m wide to allow two wheelchairs to pass each other. Where the clear width exceeds 4.0m, ramps shall be divided into two or more equal channels.

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12 This table is based on Station Planning Standard 1-371, TfL, London Underground
Public ramps shall comply with the gradients stipulated in Table 3-7.

<table>
<thead>
<tr>
<th>Table 3-7 Maximum ramp gradients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Going of flight (max length)</td>
</tr>
<tr>
<td>10.0m</td>
</tr>
<tr>
<td>5.0m</td>
</tr>
</tbody>
</table>

Ramps shall not be the only approach to stations. Where a change in level that is no greater than 0.3m a ramp is acceptable, avoiding the need for a single step on station approach.

No individual flight of a ramp shall have a going of more than 10.0m or a rise of more than 0.5m. Unless used as secondary means of access, no series of ramps shall rise more than 2.0m. Ramp flights shall have a consistent gradient.

The sizing and positioning of intermediate landings and change in direction shall be as per stipulated in Design Standards for Accessible Railway Stations, Department of Transport and Transport Scotland, March 2015.

Staircases

The minimum acceptable width of any staircase is 1.6m between handrails\textsuperscript{13}. No ‘edge effects’ are to be added when calculating staircase widths as passengers are assumed to walk up against the side handrails.

Where a central handrail is provided the minimum width on either side of this shall be 1.6m. For each central handrail 0.3m shall be added to the total width of the staircase. It is recommended that an additional central handrail is provided on stairways wider than 4.0m\textsuperscript{14}.

The above minimum widths only apply when the widths based on capacity calculations below return values that are less than these acceptable minimum widths.

The formulae below shall be used to calculate the required staircase widths between handrails for one-way and two-way flows. One-way flows are based on Fruin stairways LoS D and two-way flows are based on stairways LoS C.

<table>
<thead>
<tr>
<th>Calculating staircase widths</th>
</tr>
</thead>
<tbody>
<tr>
<td>two-way staircase width = \frac{average\ peak\ minute\ flow}{28} m</td>
</tr>
<tr>
<td>one-way staircase width = \frac{average\ peak\ minute\ flow}{35} m</td>
</tr>
</tbody>
</table>

\textsuperscript{13} Design Standards for Accessible Railway Stations, Department for Transport and Transport Scotland, March 2015.

\textsuperscript{14} Design Standards for Accessible Railway Stations, Department for Transport and Transport Scotland, March 2015.
Escalators

Generally, the number of escalators required at a station shall be calculated based on an assumed maximum throughput rate of 100 passengers per minute. At some stations a lower throughput rate may be appropriate depending on passenger behaviour and this shall be agreed with the NR SCT.

The number of escalators required for any one direction with a standard throughput rate shall be calculated as follows:

\[
\text{number of escalators} = \left\lceil \frac{\text{peak minute one-way flow}}{100} \right\rceil
\]

The calculated number of escalators shall be rounded up to the next whole number if the first number after the decimal point is more than two, and rounded down otherwise. For example, 2.3 escalators would be rounded up to three; 2.1 escalators would be rounded down to two.

In layouts where escalators can be approached obliquely an extended guarding shall be provided on the top and bottom of escalators in order to move the complex crossing movements away from the escalators. The length of such extensions shall be established based on site specific requirements and the desired run-off protection required.

At some stations, in addition to signage, it may be appropriate to use barriers designed to deter passengers with luggage from using escalators and encourage lift usage. Such barriers, depending on the design, can reduce the escalator throughput and such reduction shall be considered in calculating the number of escalators required.

In complex layouts it is beneficial to have overhead escalator directional signage.

Platform egress requirements

Where escalators or stairs are provided as the means of exiting a platform, there can be surges of alighting passengers approaching vertical circulation banks. These surges shall be accounted for within the peak minute one-way flow used in the above calculation. However, station-specific flow patterns and operations shall also be considered to ensure safe and quick platform clearance, whilst avoiding the over-design of infrastructure.

Factors to evaluate include train lengths, train stopping locations, associated walking times to vertical circulation, the orientation of stairs and escalators, and the impact of contra-flow and cross-flows.

Platforms shall always be clear of alighting passengers before the next train arrives. Analysts shall consider that reduced headways are common place in day to day running of the train timetable.
Lifts

Lifts can be provided as either the main method of vertical circulation, or as a step-free access route as per recommendations from a Diversity Impact Assessment\(^\text{15}\). Visibility and signage are important to promote lift usage.

Lift capacity is normally specified by the manufacturer and stated on a plate installed inside each lift cab (plated capacity). There may be a requirement to accommodate passenger with luggage, trollies, peddle bikes and wheelchair user’s ability to turn 360 degrees.

The following methods shall be used to calculate the number and size of lifts. Through lifts are efficient for passenger movements and shall be used wherever possible. Most passengers will not wait more than 2no lift cycles and hence provision shall be such that lift use is encouraged to improve passenger safety at stations.

The first calculation is for the number of lifts to be included at a station and is based on the transfer capacity of each lift and the passenger demand for lifts.

The second formula shall be used to calculate the size of lifts that are suitable for a given station based on the demographics of passengers using lifts.

Calculating the number of lifts

Manufacturer’s plated capacity is often based on the weight carrying capacity of the lift rather than the physical space available inside the lift car. Where lifts are intended to be used primarily by unencumbered passengers, 70% of the plated capacity shall be used to determine the number of lifts required. Where the lift is intended to be used by persons with reduced mobility (including those with luggage), only 25% of the plated capacity shall be used.

It is acknowledged that in most cases lifts will be used by a combination of customer types. Therefore the actual percentage capacity ratio used shall be interpolated between these two extremes. A survey, either at the station concerned or a similar alternative, will help to determine an appropriate factor for the calculation.

The number of lifts required (based on a known plated capacity) is calculated as follows and the result shall always be rounded up to the nearest whole lift.

\[ \text{number of lifts} = \left( \frac{\text{peak minute passengers using lifts}}{\text{capacity of lifts}} \right) \times \text{lift cycle time (min)} \]

\(^{15}\) Spaces and Places for Everyone, Network Rail Inclusive Design Strategy, 2015
Where:
Peak Minute Passengers using Lifts is derived from the peak minute flow in the busiest direction of flow along the route served by the lift, multiplied by the proportion of people expected to use the lift.

Capacity of Lifts is derived from the plated capacity multiplied by capacity ratio (as defined above).

Lift Cycle Time is the time in minutes for the lift to travel a complete cycle (including waiting time at each level).

Calculating the size of lifts

When calculating the required floor area of a lift it is recommended that 0.45m$^2$ per unencumbered passenger is provided in the lift cab.

This space provision shall be increased proportionally for passengers with reduced mobility, including those with luggage, up to 0.85m$^2$ per passenger.

Figure 3.4 below shows the range of space utilisation possible within a 16 person capacity lift, between density values of 0.45 and 0.85m$^2$ per passenger.

---

16 A standard wheelchair size of 0.8 x 1.2m has been assumed here. The average passenger footprint of 0.4m x 0.6m (circa 0.3m$^2$) is based on observations made at National Rail stations and the average human ellipse as defined in Pedestrian Planning and Design, John J. Fruin, Ph.D.
To calculate the required floor area of a lift, the formula can be rearranged to the following:

Calculating size of lifts

\[
\text{lift floor area} = \left( \frac{\text{peak minute passengers using lifts x lift cycle time (min)}}{\text{number of lifts}} \right) \times \text{sq m per passenger}
\]

Calculating waiting area requirements

As a minimum there shall be a clear space of at least 1.5m x 1.5m outside the lifts.\(^{17}\) However this is likely to be insufficient at many stations with higher passenger volumes.

The lift waiting area requirement is based on the number of passengers waiting for the lifts, which shall be calculated as follows:

Calculating passenger waiting area for lifts

\[
\text{number of waiting passengers} = \left( \frac{\text{peak minute passengers using lifts x lift cycle time (min)}}{\text{number of lifts}} \right)
\]

Using these passenger assumptions the waiting area for a lift shall be calculated using one of the two methods set out below depending upon lift configuration:

1. For walk through lifts a clear area shall be provided in front of the doors to allow waiting passenger to queue at a density between 0.45 and 0.85m\(^2\) per passenger, depending on the proportion of passengers with reduced mobility and those with luggage.

2. For single door lifts, the waiting area calculated above shall be doubled to prevent the circulating passenger flows in adjoining areas from being disrupted.

Quarter turn or through lifts shall be used to prevent discharging passengers directly towards a platform edge. If this cannot be avoided due to site constraints, and the doors are closer than 5.0m from the platform edge, a barrier shall be provided between the lift and the platform edge.

When a lift waiting area is located outside it shall have a canopy cover to provide weather protection.

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\(^{17}\) Design Standards for Accessible Railway Stations, Department for Transport and Transport Scotland, March 2015.
3.6.4 Minimum run-off distances

It is important to provide run-off (and run-on) space in front of escalators, gatelines and staircases to pull passengers away and provide a clear landing area for following passengers. These areas provide the following:

1. **Orientation time** to allow passengers to move clear and decide where to go next.
2. **Decision/action time** to decide which gate/escalator to use or to get tickets out/put them away.
3. **Queuing time** where passengers can accumulate safely.

Table 3-8 provides a list of recommended minimum run-off/run-on distances for various station elements. It also includes a number of variable length run-offs and run-ons.

These are dependent on the level of passenger flow as follows:

- **Light flow:** where the maximum peak hour flow through the relevant area of the station is less than 1000 passengers, the lowest minimum dimension shall be adhered to.
- **Heavy flow:** where the maximum peak hour flow through the relevant area of the station is greater than 3000 passengers, the highest minimum dimension shall be adhered to.

<table>
<thead>
<tr>
<th>Run-off/Run on types</th>
<th>Min. lengths (see below for variable lengths)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Escalator / travelator to gateline</td>
<td>8m-12m</td>
</tr>
<tr>
<td>Gateline to escalator / travelator</td>
<td>8m–12m</td>
</tr>
<tr>
<td>Escalator / travelator to escalator/travelator</td>
<td>8m–12m</td>
</tr>
<tr>
<td>Passageway / street exit / concourse / platform to escalator / travelator</td>
<td>6m</td>
</tr>
<tr>
<td>Escalator / travelator to passageway / street exit / concourse / platform</td>
<td>6m</td>
</tr>
<tr>
<td>Escalator/travelator to stairway</td>
<td>6m–10m</td>
</tr>
<tr>
<td>Stairway to escalator/travelator</td>
<td>6m–10m</td>
</tr>
<tr>
<td>Gateline to passageway/concourse/street/platform</td>
<td>6m</td>
</tr>
<tr>
<td>Passageway/concourse/street/platform to gateline</td>
<td>6m</td>
</tr>
<tr>
<td>Stairway to gateline</td>
<td>6m–10m</td>
</tr>
<tr>
<td>Gateline to stairway</td>
<td>6m–10m</td>
</tr>
<tr>
<td>Stairway to passageway/stair</td>
<td>4m</td>
</tr>
<tr>
<td>Passageway/street to stairway</td>
<td>4m</td>
</tr>
</tbody>
</table>
• **Medium flow:** where the maximum peak hour flow through the relevant area of the station is between 1000 and 3000 passengers the run off length shall be calculated using:

\[
\text{run-off length} = \left\{ \frac{\text{peak hour flow} - 1000}{500} \right\} \text{m}
\]

Run-offs leading to passageways shall be provided before any change in direction or reduction in width, and before any junctions with other passageways.

Queuing areas at gatelines and their relationship with run-off distances are discussed in more detail in Section 3.2.

In cases where run-off distances cannot be achieved a site specific risk assessment shall be undertaken to ensure the appropriate mitigation measures are in place and the residual risks are as low as reasonably practicable (ALARP).
4 Planning for Abnormal Conditions

It is important to ensure that stations continue to function acceptably during planned and unplanned events affecting train service, passenger demand or station layout.

The minimum space requirements outlined in Section 3 relate to station performance during “normal” conditions. However, it is important to ensure that a station continues to function acceptably during various abnormal scenarios. The temporary nature of these scenarios lowers the thresholds in terms of acceptable density conditions and at the same time ensures that passenger safety is maintained (see Figure 1.1).

4.1 Perturbation

Service perturbation is defined as a significant delay to trains, leading to increased waiting in the station environment, either on the platforms or the concourses. The impact of service perturbation is different for each station.

For termini and larger interchange stations, perturbation represents a 15-minute delay to one group of services (e.g. Main Line or Relief Line), or in one direction (e.g. Up or Down Line). For smaller stations, perturbation represents the cancellation of a train service. For assessment purposes the busiest 15-minute period and the busiest train service respectively shall be used.

During perturbation station management follows the procedures outlined in station crowd management plans, which detail a number of controls in response to the level of disruption. These include introducing queueing systems, closing entrances, opening automatic ticket gates, removing retail seating areas, stopping or reversing escalators and using police assistance.

Scope and crowd control assumptions for any perturbation analysis shall be agreed with the NR SCT and station management teams, as these will be unique to each individual station.

Following any period of perturbation, the train services enter into a recovery period before the running timetable is fully restored. The recovery period depends on a number of factors including the network performance and the displacement of trains. This recovery period may put pressure on the station infrastructure and shall form part of any perturbation analysis.

Points to consider include:

- The backlog of trains and the frequency with which they will arrive at the station following perturbation.
- The capacity of the trains and the number of boarders and alighters, taking into account the impact of cancellations and perturbation at preceding stations.
4.1.1 **Example levels of service observed at stations**

Figures 4.1 and 4.2 are images from London Waterloo station concourse. The images show different levels of service observed during normal operations and an example of high density observed during a train service perturbation.

**Figure 4.1 Levels of service normally observed over station concourses, London Waterloo**

- Average density of ~1.9 m² per pax (LoS A queuing)
- Average density of ~1.0 m² per pax (LoS B queuing)

This density level may be observed during less busy times on station concourses. It allows sufficient space for standing and free circulation through the waiting area without disturbing the queuing passengers.

**Figure 4.2 Concourse crowding at Waterloo station during train service disruptions**

Service disruption should be included as a sensitivity test during design development. Passenger density in open concourses should meet the criteria of 0.45 m² per passenger for perturbation assessments.
4.2 Construction

Careful planning and management of construction phasing is required to complete project works on time whilst maintaining safe and efficient station operations. The scope of construction phasing scenarios shall be agreed with the NR SCT, the project and station management teams.

Of particular importance during temporary construction works is the safety of passengers during service perturbation and emergency evacuation. During each assessment the busiest time period for the particular area in question shall be used.

4.3 Special events

Events taking place at or in the vicinity of stations can lead to a temporary change in passenger flows at stations and their curtilage. A passenger count may need to be carried out to estimate change in flows.

During special events station management follows the procedures outlined in the station crowd management plans. This specifies a number of controls for ensuring passengers can pass through the station safely and quickly. Scope of any special event analysis carried out shall therefore be agreed with the NR SCT, the project and station management teams.

4.4 Emergency evacuation

Emergency evacuations of all or part of a station are required to meet standard escape time. Evacuation may occur due to fire, security reasons or overcrowding. Any station design shall consider the following two emergency scenarios:

4.4.1 Train on fire scenario

The evacuation load shall be assumed to include the following:

- Station occupancy at time of evacuation shall be based on peak usage, incorporating a five minute delay to the scheduled train service in the busiest direction only.

The assumed five minute delay shall result in a build-up of passengers during the high peak, either on the concourse or platforms, depending on the station type. In this instance the busiest direction refers to the train service or platform that is used by the greatest volume of boarding passengers, so as to maximise the accumulation load.

- In addition to the above all occupants of a crush-loaded train (on fire), plus those normally expected to alight from the next train in the other direction or any other lines, shall be evacuated.
A train service in its typical formation for the appropriate station or route shall be assumed to arrive crush loaded at the first platform. The next timetabled train service shall arrive into the station at the allocated platform. All passengers within the station and alighting from these two trains shall be evacuated in accordance with the individual station fire evacuation plan.

- All exit routes can be counted as available for use and escalators continue to run as before the emergency.
- The analysis shall not assume passengers passing along the platform or through the train past the source of a fire.

4.4.2 Fire within the station structure

The evacuation load shall be assumed to include the following:

- Occupancy at time of evacuation shall be based on peak usage with 5-minute delay to the scheduled train service in the busiest direction only.

This shall result in a build-up of passengers during the peak 15-minute period, either on the concourse or platforms, depending on the station type. In this instance the busiest direction refers to the train service or platform that is used by the greatest volume of boarding passengers, so as to maximise the accumulation.

- The exit route with the greatest capacity shall be discounted (as it could be blocked by fire).

This route shall be calculated based on the flow that can be achieved through each exit route, which is based on the width and flow rate per minute. Refer to Figure 1.1 for guidance on the flow rates to be used during evacuations.

- Passengers waiting to board plus those normally alighting from the next train in each direction shall be evacuated.

The next two timetabled train services, during the peak 15-minute period, shall be assumed to arrive into the station at their allocated platforms. All passengers within the station and alighting from these two trains shall be evacuated in accordance with the station fire evacuation plan.

It is recognised that in some cases the timetable is unlikely to deliver two trains simultaneously. As a worse-case scenario it would be appropriate to adjust the arrival time of one of the services to coincide with the arrival of the other.
4.4.3 Emergency Evacuation Assessments

When carrying out emergency evacuation assessments it is advised that a number of scenarios are considered to stress test various elements and areas of the station.

This shall be done in collaboration with the project, station management team and the Network Rail Fire Safety Engineer, in accordance with the station fire evacuation plan.

4.4.4 Maximum Evacuation Times

Where modification or refurbishments are planned for an existing surface and sub-surface railway station the following maximum times shall be used to validate the proposed design:

Surface platforms:
- 8 minutes for non-raffed platforms.
- 5 minutes for raffed platforms.

Additional evacuation time allowed through station concourse or to final exit:
- 2 minutes for raffed concourse with escape in one direction only.
- 3 minutes for raffed concourse with escape in more than one direction.
- 3 minutes for non-raffed concourse with escape in one direction only.
- 4 minutes for non-raffed concourse with escape in more than one direction.

Sub-surface platforms:
- 4 minutes to evacuate platforms.
- Additional 2 minutes to reach protected route.

4.4.5 Fire Engineered Solution

There may be instances where existing platforms cannot meet the evacuation times given above because of existing architectural constraints such as stairway and subway widths. In such cases the following guidance is applicable.

Where any fire engineered approach is to be considered the evacuation assessment shall be based on the Actual Safe Evacuation Time (ASET) against the Required Safe Evacuation Time (RSET).

In most cases, it will be loss of visibility due to the spread of smoke that determines the initial threat to life and consequently the available safe egress time (ASET).

RSET represents the time taken (from ignition) for all of the occupants to reach a place of safety.

The tenability criteria used for this assessment and the margin of safety must be agreed with the Network Rail Fire Safety Engineer.
5 Station Performance Categorisation

All assessments shall rate the performance of stations with respect to the scenarios analysed.

5.1 Station performance categorisation

In some cases one or more station elements may impede the circulation of passengers if the core requirements defined in this document are not correctly met. This can have a direct impact on public safety and train performance. These risks shall be articulated by the analysts using the analysis outputs e.g. high passenger density near platform edge or high density on stairs that may result in slip, trips and falls.

Analysts shall rate the performance of a station design based on the assumed passenger demand scenarios and different train timetables, as relevant. The station design performance rating shall be based on the following categories:

Normal – Applicable where sizing of individual station elements is such that the overall station is expected to operate with minimal management interventions and no residual risks have been identified to passenger safety or train performance.

Abnormal – If the sizing of individual station elements is such that parts of the station regularly needs planned management interventions to reduce the risks to passenger safety and train performance. If it is not possible to improve the situation through design then a risk assessment shall be undertaken to verify that the residual risks are within ALARP level after implementing any mitigation measures.

Degraded – In cases where the sizing of station infrastructure is such that regular management interventions fail to reduce the safety and train performance risks. Here, further disruptive measures are necessary. These may include; changes to the train timetable, altering train lengths, diverting passengers to other stations or partial station closures. In such cases immediate mitigation measures are required to temporarily reduce the identified risks down to an ALARP level until effective design and operational interventions can be made to move into ‘normal’ or ‘abnormal’ categories.

Emergency – This is a hypothetical situation where the safety and train performance risks cannot be reduced even after introducing any reasonable mitigation measures. Such a situation should never be realised because Network Rail’s Long Term Planning Process will ensure a periodic review of station environments and actively seek funding to deliver station enhancements.
Appendix A

Data Requirement for Assessments

The following checklist shall be included in all remits to clearly identify gaps in data.

<table>
<thead>
<tr>
<th>Data Element</th>
<th>Static assessment</th>
<th>Microsimulation Analysis</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed station entry/exit flows</td>
<td>X</td>
<td>X</td>
<td>Survey</td>
</tr>
<tr>
<td>Observed origin-destination matrix</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observed origin-destination matrix</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observed counts at key locations</td>
<td></td>
<td></td>
<td>Survey</td>
</tr>
<tr>
<td>Recorded gate data</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recorded trips (e.g. LU) data</td>
<td></td>
<td></td>
<td>Station management or TOC</td>
</tr>
<tr>
<td>Forecast station entry/exit flows</td>
<td>X</td>
<td></td>
<td>NR project team</td>
</tr>
<tr>
<td>Per-passenger entry/exit flows</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observed passenger journey times, dwell times</td>
<td></td>
<td></td>
<td>Survey</td>
</tr>
<tr>
<td>Video footage showing passenger activity</td>
<td></td>
<td></td>
<td>Survey</td>
</tr>
<tr>
<td>Existing station CAD drawings</td>
<td>X</td>
<td>X</td>
<td>NR Project team</td>
</tr>
<tr>
<td>Proposed station CAD drawings</td>
<td></td>
<td>X</td>
<td>Design consultant</td>
</tr>
<tr>
<td>Train stock CAD drawings, stopping positions</td>
<td></td>
<td></td>
<td>TOC</td>
</tr>
<tr>
<td>Train timetables</td>
<td></td>
<td>X</td>
<td>NR Project team</td>
</tr>
<tr>
<td>Operational configuration of gates and operators</td>
<td></td>
<td></td>
<td>Station management or TOC</td>
</tr>
<tr>
<td>Station control plan</td>
<td></td>
<td>X</td>
<td>Station management or TOC</td>
</tr>
<tr>
<td>Evacuation plan</td>
<td></td>
<td>X</td>
<td>Station management or TOC</td>
</tr>
<tr>
<td>Station signage</td>
<td></td>
<td>X</td>
<td>Survey or Design consultant</td>
</tr>
<tr>
<td>Ticket purchase activity</td>
<td></td>
<td>X</td>
<td>Survey</td>
</tr>
<tr>
<td>Lift capacities and cycle times</td>
<td></td>
<td>X</td>
<td>Survey</td>
</tr>
<tr>
<td>Usage of secondary revenue facilities e.g. retail</td>
<td></td>
<td></td>
<td>Survey</td>
</tr>
</tbody>
</table>

X = Mandatory minimum requirement for assessments.
0 = Non-mandatory, but useful information for assessments and validation.

Typically, the following passenger demand datasets are required depending on complexity of the station layout and operations, and the type of analysis:

Station usage

This data shall be collected for 5-minute intervals as a minimum during the peak periods, and shall include all station users. Counts shall be classified using the following categories -

i. Commuters e.g. carrying regular sized rucksack, handbag or laptop bags

ii. Passengers with medium or large luggage e.g. suitcase, large sports bag or foldable cycle

iii. Passengers with full sized pedal cycles

iv. Passengers with young children or prams

v. Wheelchair passengers

Any deviation from the standard classified counts shall be discussed with a member of the NR SCT.

Automatic ticket barrier usage

This automatic counting data, if available, can be used to validate the throughput of individual gates, check counts recorded using other methods, or as a proxy for station usage counts.
Origin and destination pairing

This data can be gathered by various methods including: ‘colour card’ survey, interviews, ‘people following’, video analytics or by using more advanced methods that rely on technology to track devices that passengers carry with them i.e. mobile phones and tablet devices.

Peak one minute flow

This shall be used to understand the concentration of flow in different areas of station; e.g. flow on stairs, passageways and through ticket barriers.

Counts at other key locations

These shall be recorded for 5-minute intervals during peak times and can be used to validate routing of passengers within stations; e.g. counts at stairs, passageways, escalators and ticket gates.

Train usage

Some platforms may be served by multiple train services with different loadings. Furthermore, there may be a bias towards the use of certain train carriages (e.g. car 5 could be more attractive due to the position of stairs at the station).

This may vary by train service and time of day. Boarding and alighting data can be collected using manual survey or advanced methods such as video analytics or passengers tracking.

Journey time

These measurements shall be made during free flow conditions in order to benchmark unimpeded journey times experienced by passengers. This can be used to calculate the delay caused by congestion and support business case development.

Passenger behaviour

Video footage recorded at different locations can be very useful to understand behavioural characteristics of passengers that may be specific to a station environment.

Train operations

The actual train arrival, departure and dwell times shall be recorded. In case of stations where passengers wait in a concourse area away from the platforms, the boarding announcement time shall also be observed. Appendix E includes an example of train timetable information that is available from the TOC or Network Rail.

Train rolling stock

At some stations, train services using different rolling stock may call at the same platform and this may vary by time of day (i.e. peak and off-peak services using different rolling stock). Train stopping locations shall be observed for different services and type of rolling stock. Note that the number of doors per carriage, width of each door, number of seats and standing capacity may vary depending on the type of rolling stock.

Platform occupancy

At many stations platforms can be used by trains serving different routes. At such stations passengers dwell on the platform for the first, second or subsequent services departing from the same platform. At such stations platform occupancy shall be recorded to include in capacity calculations for platform width and canopy sizing. This data can be collected by video analysis with a count at set intervals or before and after every train departure. Alternatively passenger tracking can be used if deemed appropriate.
Appendix B

Documentation and Deliverables

It is important that all assumptions, demand data, analysis, outputs and recommendations are reported in a clear and succinct manner.

The following reports shall be produced for a station capacity assessment depending upon the method of analysis used.

- Baseline report including site visit notes and survey observations
- Model validation report in case of microsimulation analysis
- Capacity assessment report
- Audit report

Baseline report

All observations and information gathered from the initial site visit and survey shall be summarised in a Baseline report. The findings of this study may have an impact on the type and scope of the assessment. It is recommended for major station redevelopment schemes, a standalone baseline study shall be undertaken.

Model validation report

Validation is a process of confirming that a microsimulation model accurately reflects reality, and involves comparing simulated outputs from the current situation or Base Year with real life observations and other survey data.

Model validation is a default requirement when undertaking microsimulation analyses for Network Rail. Deviation from this requirement shall be discussed and agreed with the NR SCT.

A base year model shall always be validated when the microsimulation is being undertaken for an existing station. The microsimulation model is considered validated if the variations between simulated outputs and on-site observations (or survey) are less than 10%. If the variations are greater than 10% then the reasons for this shall be investigated and discussed with the NR SCT. If necessary, the base model shall be revised to achieve the best validation that is practically possible.

A validation study shall cover the following:

- Visual validation

This is the initial step where the animated videos from a microsimulation model are compared with real life video footage or photographs. The animation of simulated passenger movements is run to check for any obvious inconsistencies in routing, behaviour and passenger volumes.

Passenger densities observed in real life shall be compared against the simulated congestion levels e.g. cumulative mean density and corresponding Fruin LoS.
• Origin-Destination and cordon count checks

The surveyed counts and input demand matrices shall be compared against the output origin-destination matrix and cordon counts at specific locations. This is to confirm that the passenger volumes and route choice have been accurately simulated in the model.

• Journey time comparison

The simulated journey times on key routes shall be compared against the observed journey times in free-flow and crowded conditions. This is to ensure confidence in the simulated passenger behaviour in the model.

• Flow-rate comparison

The simulated flow-rates on stairs and along passageways shall be compared with the on-site observations. This is to ensure confidence in simulated walk speeds and passenger behaviour.

Capacity assessment report

This is the main deliverable for a station capacity assessment. This report shall clearly explain the key assumptions, passenger demand, station layout and operations being assessed.

A good capacity assessment report shall include the relevant analysis outputs (see Appendix C and D) and recommendations for the design and operations team for NR to pursue.

Station designs shall be categorised based on Section 5.1 in relation to the different passenger demand and train timetable scenarios considered in the analysis.

Any areas of non-compliances with industry standards and planning criteria stipulated here shall be clearly highlighted in reports and suitable design solutions shall be implemented or recommended.

Other operational mitigation measures shall only be recommended where there is no feasible design solution. In such cases longevity of operational controls and residual risks shall be clearly stated.

Audit report

The following items shall be covered within an audit:

• Suitability of demand data and other operational assumptions

• Accuracy of passenger and train data, and other modelling assumptions

• Compliance with general industry best practice methods for model development

• Check if relevant scenarios have been assessed

• Accuracy and relevance of the range of modelling outputs included in the report

It is recommended that a structured audit checklist is used and shall be relevant to the chosen method for capacity analysis.

In some cases external audit of microsimulation models and reports may be necessary. The NR SCT will identify when such an external audit is required.
Appendix C

Presentation of Outputs

The analysis requirements will be defined clearly in the remit. The following outputs are generally useful depending upon the type of analysis undertaken.

Static analysis outputs

The outputs that can be derived from a spreadsheet based static analysis include:

- **Gatelines**
  Number of gates in a gateline, configuration of gates for various scenarios (entry / exit), time to process peak demand and minimum run-off.

- **Concourse**
  Sizing of concourse space and CIS accumulation areas, density at peak times.

- **Stairs and passageways**
  Clear width required for peak passenger demand, density and flow-rate at peak times, journey time along stair or passageway for free-flow and crowded conditions.

- **Lifts**
  Size of lifts and waiting area in front of doors, number of lifts required based on passenger demand, lift capacity and cycle time, average waiting times during peak periods.

- **Escalators**
  Number of escalators, minimum run-on and run-offs, operational configuration for various scenarios (up / down) based on passenger demand, peak flow-rate.

- **Platforms**
  Width of platforms and platform extensions, density at peak times, location of platform furniture, canopy length, and platform clearance time after peak train arrival.

- **Evacuation times**
  Using specified walking speeds and evacuation flow-rates through different areas of the station.

Microsimulation analysis outputs

Typically the following outputs can be derived from a microsimulation model of passenger movement in addition to the actual animation of passenger movement in 2D or 3D format. Outputs that are most relevant to a project or study shall be presented in a capacity assessment report.

- **Gatelines**
  Peak 5-minute maps showing mean density based on Fruin queuing LoS scale.

  Flow-rates during peak periods to show the maximum and average throughput that is simulated in the models. In most cases, the throughput of individual gates shall be capped at 25ppm per gate (see section 3.2 for different types of gates used on the network).
Simulated gateline clearance times shall be presented as a histogram (see Figure C1).

- **Concourse**
  Peak 15-minute maps showing mean density based on Fruin walkways LoS scale. A smaller time interval may be used at some stations to assess performance in greater detail.

  Space utilisation maps to highlight the heavily used areas and paths, and under-utilised areas.

  Average and maximum journey times between all different locations during the peak periods. Journey times presented as histograms between each origin and destination pair.

- **Stairs and passageways**
  Peak 5-minute maps showing mean density based on Fruin stairway and walkway LoS, as applicable on the stairs and along passageways.

  Peak 5-minute mean density maps showing Fruin queuing LoS at the top and bottom of stairs.

  Maximum and average flow-rate simulated on stairs and along passageways.

  Average and maximum journey times on stairs and along passageways during the peak periods. Journey times may be presented as histograms.

- **Lifts**
  Peak 5-minute mean density maps showing Fruin queuing LoS in the waiting area in front of the lift doors.

  Maximum and average number of passenger queuing for the lifts in a simulation.

  Maximum and average transfer time between different levels including waiting time.

- **Escalators**
  Maximum and average flow-rate simulated on escalators.

- **Platforms**
  Peak 5-minute mean density maps showing Fruin walkway LoS over platforms and peak 15-minute mean density maps showing queuing LoS.

  Maximum and average waiting times for passenger on platforms in a simulation. This may be as a histogram for each train service, if required.

  Maximum and average platform clearance time for alighting passengers in the simulation. This shall be measured from the train doors to the platform exit.

- **Emergency egress analysis**
  Evacuation maps showing the length of time taken by the last person to clear different areas of a station.
Presentation of outputs

Journey times can be recorded from a microsimulation model and presented as shown in the example below. This format can be adopted for presenting gateline or platform clearance times, journey times on different routes, and evacuation times through different exits. In some cases it may be useful to present journey times separately for different types of station users i.e. commuters and tourists or PRMs.

Simulated flow-rates through stairs, escalators and passageways in different areas of a station can be recorded from a microsimulation model, and compared against the planning criteria promoted by this guidance.

Graphical outputs such as cumulative mean or cumulative high density metrics, space utilisation and evacuation times can be exported from microsimulation models.
### Appendix D

**Interpretation of Microsimulation Analysis Outputs**

This table provides a summary of the typical outputs that can be extracted from a microsimulation model and the interpretation based on the relevant planning criteria.

It should be noted that different planning criteria apply to normal and abnormal conditions.

<table>
<thead>
<tr>
<th>Station element</th>
<th>Modelling output and planning criteria</th>
</tr>
</thead>
</table>
| **Gatelines that are separated from platforms** | **Exit Gates**  
All exiting passengers alighting from one or more concurrent arrivals in the peak periods can pass through the exit gates in 2 minutes after the first person has reached the ticket gates.  
The outputs from dynamic modelling simulation analysis should be presented in the form of a histogram showing clearance times and percentage of alighting passengers from individual or concurrent train arrivals.  
Peak 5-minute cumulative mean density maps showing queuing LoS should demonstrate that the accumulation of passengers on the paid side remain within acceptable density levels i.e. not exceeding LoS D (queuing), and does not impede circulation of other passengers. |
| **Entry Gates**                        | Gatelines should allow the peak 5-minute entry demand to pass through the gates in 5 minutes with no prolonged build-up of congestion.  
Peak 5-minute cumulative mean density maps showing queuing LoS should demonstrate that the simulated accumulation of passengers on the unpaid side remains within acceptable density levels i.e. not exceeding LoS D (queuing). This density level is generally acceptable as long as other circulation routes through the station are not affected. |
| **Gatelines adjacent to platforms**    | **Exit Gates**  
For the peak train arrivals, all exiting passengers should be able to pass through the gates in 4 minutes or less after the first person has reached the gateline. This clearance time threshold is station specific. The paid side accumulation of passengers near the gateline should not impede other circulating movements.  
The outputs from dynamic simulation analysis should be presented in the form of a histogram showing clearance times and percentage of alighting passengers from individual or concurrent train arrivals.  
Peak 5-minute cumulative mean density maps showing queuing LoS should demonstrate that the simulated passenger accumulation on the paid side remains within acceptable density levels i.e. not exceeding LoS D (queuing). |
| **Entry Gates**                        | Gatelines should allow the peak 5-minute entry demand to pass through the gates in 5 minutes with no prolonged build-up of congestion.  
Peak 5-min cumulative mean density maps showing queuing LoS to demonstrate that the simulated queues on the un-paid side remain within acceptable density levels i.e. not exceeding LoS D (queuing).  
Queueing at this density is generally acceptable as long as other circulation routes through the station are not affected. |
<table>
<thead>
<tr>
<th>Station element</th>
<th>Modelling output and planning criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Passageway</strong></td>
<td><strong>One-way</strong> Simulated average flow-rate during the peak 5 minutes should not exceed the planning criteria of 50pppm. It may be acceptable for flow-rates to exceed the planning threshold for a short duration of time if other circulating movements are not impeded and passenger safety is not compromised. Flow-rate analysis similar to the example in Figure C2 should show that high flow-rates occur for no more than 2 minutes during peak hours. Peak 5-minute cumulative mean density maps should show density levels not exceeding <strong>LoS D (walkways)</strong>.</td>
</tr>
<tr>
<td><strong>Two-way</strong></td>
<td>Simulated average flow-rate during the peak 5 minutes should not exceed the planning criteria of 40pppm. It may be acceptable for flow-rates to exceed the planning threshold for a short duration of time if other circulating movements are not impeded and passenger safety is not compromised. Flow-rate analysis similar to the example in Figure C2 should show that high flow-rates occur for no more than 2 minutes during peak hours. Peak 5-minute cumulative mean density maps should show density levels not exceeding <strong>LoS C (walkways)</strong>.</td>
</tr>
<tr>
<td><strong>Stairway</strong></td>
<td><strong>One-way</strong> Simulated average flow-rate during the peak 5 minutes should not exceed the planning criteria of 35pppm. It may be acceptable for flow-rates to exceed the planning threshold for a short duration of time if other circulating movements are not impeded and passenger safety is not compromised. Flow-rate analysis similar to the example in Figure C2 should show that high flow-rates occur for no more than 2 minutes during peak hours. Peak 5-minute cumulative mean density maps should show density levels not exceeding <strong>LoS D (stairways)</strong>.</td>
</tr>
<tr>
<td><strong>Two-way</strong></td>
<td>Simulated average flow-rate during the peak 5 minutes should not exceed the planning criteria of 28pppm. It may be acceptable for flow-rates to exceed the planning threshold for a short duration of time if passenger safety on stairs is not compromised and there is no perceptible queuing at the top or bottom of the stairs. Flow-rate analysis similar to the example in Figure C2 should show that high flow-rates occur for no more than 2 minutes during the peak hours. Peak 5-minute cumulative mean density maps should show density levels not exceeding <strong>LoS C (stairways)</strong>.</td>
</tr>
<tr>
<td><strong>Escalators</strong></td>
<td>Any direction Simulated average flow-rate during the peak 5 minutes should not exceed the planning criteria of 100pppm. At some stations a lower planning criteria may be more appropriate as discussed in Section 3.6.3. It may be acceptable for flow-rates to exceed the relevant planning threshold for a short duration of time if passenger safety on escalators is not compromised and there is no perceptible queuing at the top or bottom of an escalator. Flow-rate analysis similar to the example in Figure C2 should show that high flow-rates occur for no more than 2 minutes during the peak hours.</td>
</tr>
<tr>
<td><strong>Ramps, Stairways, Escalators and Travelators</strong></td>
<td>On approach There should be no perceptible queuing on approach to ramps, escalators, travelators and stairs. Peak 5-minute cumulative mean density maps at either ends of such circulation elements should show that density levels do not exceed <strong>LoS C (queuing)</strong> in these areas.</td>
</tr>
<tr>
<td>Station element</td>
<td>Modelling output and planning criteria</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Concourse Circulation areas</td>
<td>Peak 15-minute cumulative mean density maps should show density levels not exceeding $\text{LoS C (walkway)}$, i.e. 1.8sqm per person. Space utilisation maps may help optimise concourse layouts by highlighting busy route and areas that are under-utilised.</td>
</tr>
<tr>
<td>Dwelling areas near CIS</td>
<td>Peak 15-minute cumulative mean density maps should show that density levels do not exceed $\text{LoS B (queuing)}$, i.e. 1.0sqm per person. Apart from localised hot-spots with higher density, the average density should not exceed this threshold.</td>
</tr>
<tr>
<td>Platforms Waiting areas</td>
<td>It is acknowledged that there will be localised areas of higher densities in certain areas of platforms (particularly around train carriage doors). The average 5-minute density within waiting areas in front of all carriage for the peak period should not exceed $\text{LoS C (queuing)}$, i.e. 0.65sqm per person. Waiting areas and areas of localised queuing (e.g. in front of popular carriages) should not exceed $\text{LoS C (queuing)}$, no more than 5-minute during the peak 15-minute period. Platform clearance time should not exceed the minimum gap between trains (i.e. based on signalling constraints, as opposed to timetabling).</td>
</tr>
<tr>
<td>Circulation areas</td>
<td>The average 5-minute density in circulation areas on platforms should not exceed $\text{LoS C (walkways)}$, during peak times. Localised queuing should not impede movement of passengers along the platform. This should be based on the review of average densities (for circulation and waiting areas) and video animations for the peak periods.</td>
</tr>
</tbody>
</table>

*Note: the colour codes in this table refer to the corresponding Fruin Levels of Service for walkways, stairways and queuing, as specified.*
Appendix E

Train Timetable Template

This table gives an example of timetable information that may be available from the TOC or Network Rail.
Appendix F

Other Relevant Reference Documents

A range of Network Rail and Industry documents have been referred to compile this guidance.

1. Station Design Principles for Network Rail, March 2015
4. Developing Modern Facilities at Stations, Railtrack, November 1998
6. National Control Instructions and Approved Code of Practice Section 4.7 Station Overcrowding and Special Events, Network Rail, June 2008
7. National Control Instructions and Approved Code of Practice Section 4.6 Train Evacuation, Network Rail, June 2008
8. Company Fire Safety Handbook, Network Rail, September 2010
10. Voluntary Rail Industry Standard for Station Infrastructure RIS-7700-INS, Railway Safety and Standards Board, June 2010
12. Interface between Station Platforms, Track and Trains GI/RT7016, Mandatory Requirements, Railway Safety and Standards Board, April 2010
13. Rail Safety Principals and Guidelines, Health and Safety Executive
15. Technical Specification for Interoperability : Accessibility for Persons with Reduced Mobility for high Speed and – Conventional Lines on the Trans-European Rail Network, PRM-TSI
17. Station Planning Standards and Guidelines, TfL, London Underground
DOCUMENT IDENTITY
Network Rail Station Capacity Planning Guidance

AUTHORISATION CONTROL

<table>
<thead>
<tr>
<th>Author</th>
<th>Approver</th>
</tr>
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<tr>
<td>Shravan Patel</td>
<td>Isabelle Milford</td>
</tr>
<tr>
<td>Senior Station Capacity Planner</td>
<td>Station Capacity Manager</td>
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REVISION CONTROL

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<tr>
<td>1.0</td>
<td>May 2011</td>
<td>First Issue</td>
</tr>
<tr>
<td>2.0</td>
<td>November 2016</td>
<td>Formulae updated for gatelines, platforms, lifts and canopy lengths. Clarity on other design considerations for escalators, overhead signage, planning thresholds, interpretation of dynamic analysis outputs and constrained flow concepts to prevent over design. Updates relating to changes in industry standards and codes of practice. Re-write to improve usability.</td>
</tr>
</tbody>
</table>